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SM2A-03-BLOCK II-J-(2)

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# APOLLO OPERATIONS HANDBOOK

## COMMAND AND SERVICE MODULES
## J-SERIES MISSIONS

CSM 112 THRU 115

### Volume 2
### Operational Procedures

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## FOREWORD

This handbook contains the flight crew operational procedures for all active J-series spacecraft.

Volume II constitutes the crew Normal/Backup, Abort, Malfunction and Emergency procedures. Normal procedures are defined as those used if all systems are operating normally. Backup procedures are those used to accomplish the objective of the normal procedures when system failure or some other anomaly prevents use of the normal procedures. Malfunction and Emergency procedures encompass the recognition, diagnosis, and corrective action for system malfunctions or failure.

### Spacecraft Page Identification

Pages of this handbook which are usable only on a single J-series vehicle are identified by including the spacecraft number parenthetically as a part of the page number.

Pages applicable to a specific series of vehicles are identified by including the spacecraft number and the letter S parenthetically as a part of the page number. The "S" indicates the page is applicable to the spacecraft number shown and to subsequent vehicles as well.

Common pages (pages with no spacecraft identification in the page number) are used for all J-series spacecraft.

Some pages have been repeated in order to satisfy page requirements for all spacecraft covered by the current handbook.

### Utilization and Updates

This handbook concept requires the use of specific pages to provide specific vehicle coverage. It is suggested that the list of effective pages in the front of the handbook be used when changes to the book are made or to verify a specific vehicle configuration of the manual.

To prepare the manual for use on a particular vehicle, select the complete set of common pages and those pages indicated for a particular vehicle as indicated on the list of effective pages.

When pages identified as applicable only to other vehicles have been removed in preparation of a manual for a specific vehicle, redundant pages will have been eliminated. Do not discard the removed pages. These pages are current for other vehicles until superseded by subsequent change.

Volume 1 - Spacecraft Description, SM2A-03-BLOCK II-(1), is bound separately and contains the description portion of the spacecraft systems and equipment. User of Volume 2 procedures should be thoroughly familiar with spacecraft and system descriptions in Volume 1.

Comments or suggested change to this handbook should be addressed to the Spacecraft Systems Branch, FCSD, MSC, Office Code CF22, Telephone HU3-5558.

# INTRODUCTION

## PROCEDURE COLUMNS

Procedural steps in this section are presented in tabular form and in numerical sequence. Steps are further organized by subgroups into related functions. Column headings of the Normal/Backup procedures consist of STATION/TIME (STA/T), STEP, PROCEDURE, PANEL and REMARKS. An explanation of each of these column headings is provided as follows:

| | |
|---|---|
| STA/T | The station is equivalent to the crewmember assigned to the spacecraft location where a procedure or step is performed. Station CDR (commander), CMP (command module pilot) and LMP (lunar module pilot) correspond to the left, middle, and right crew couch positions, respectively. The CMP also pertains to the lower equipment bays inaccessible to the other crewmembers. The time column (T) will contain mission time, event time or altitudes. |
| STEP | The step is the numerical indication of the elements to be followed and their sequence in performing a complete procedure. |
| PROCEDURE | The procedure is a group of steps or overall task involved in performing a complete function or operation. If a perimeter of Xs are around a procedure, it constitutes a backup procedure relative to the preceding step. |
| PANEL | The panel location is the location of a particular control or display by panel number. The main display console (MDC) panels are numbered 1 through 12; the lower equipment bay (LEB), 100 through 181; the right-hand equipment bay (RHEB), 225 through 278; the left-hand equipment bay (LHEB), 325 through 382; the left-hand forward equipment bay (LHFEB), 300 through 306; and the upper equipment bay (UEB), 600 through 604 and 13 - ORDEAL BOX. (See figure B-1 for panel locations.) |

REMARKS — This column provides the rationale supporting the adjacent step and the operational procedure. Rationale will grow in scope as the operational procedures are refined through continued application by the Flight Crew as applied during mission simulation using Apollo evaluators and simulators. As the Flight Crew becomes more familiar with the spacecraft and increases its proficiency, the Abbreviated Checklist is expected to diminish in overall coverage. Volume 2, however, with its supporting rationale will become a repository of comprehensive data providing a reference baseline to the Abbreviated Checklist and for use by support personnel more recently assigned to the program.

## SHORT-FORM NOMENCLATURE AND ABBREVIATIONS

Spacecraft controls and displays and their relative positions and indications are called out by their respective placard titles. Exceptions have been taken, where titles are lengthy by adoption of short-form nomenclature.

Whenever a designated callout refers to a control or display, it is identified by one of the following:

| | |
|---|---|
| Light | lt |
| Switch | sw |
| Rotary type switch | sel |
| Circuit breaker | cb |
| Talkback indicator | tb |
| Valve | vlv |
| Indicator | ind |
| Pushbutton | pb |
| Potentiometer or rheostat | cont |
| Thumbwheel | tw |

For Symbols and Definitions, refer to Appendix A in the Apollo Operations Handbook, Block II Spacecraft, Volume 1 - Spacecraft Description (SM2A-03-BLOCK II-(1) (H&J).

# SECTION 4

# NORMAL/BACKUP PROCEDURES

Normal/backup procedures consist of detail control actions and anticipated displays for accomplishing CSM systems management, flight control, navigation, and experimental procedures under nominal mission operating conditions. Approved alternate operating methods and backup systems procedures are included, and options indicated where applicable to provide maximum vehicle capability and operational flexibility. As an aid to the user, supporting rationale, system operating limitations, and remarks clarifying unique or obscure operating methods are provided adjacent to or keyed to affected locations in the procedures.

## 4.1 BACKUP CREW PRELAUNCH CHECKS

Prelaunch procedures consist of operational and configuration checks performed by backup flight crew prior to ingress of prime crew. Procedures have been sequenced so they can be more easily compared with other prelaunch documents. In order to keep them closely aligned, redundant switch settings may appear in more than one area and GDC align procedures have been repeated wherever necessary. It is assumed that a complete prelaunch checkout, including loose gear stowage, has been performed by ground support personnel, prior to backup crew ingress into command module, and that all systems are in an active configuration as required at time of ingress. Spacecraft suit circuit shall have been purged and oxygen content verified to be 95% minimum. Backup crew will utilize facility headsets until service structure is clear of vehicle, as there will be no VHF AM or S BAND transmission until that time. Refer to Appendix B for cabin switch/control position prior to backup crew cabin ingress.

### 4.1.1 C&WS STATUS CHECK

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | C/W NORM - NORM | 2 | |
| | C/W CSM - CSM | | |
| | C/W PWR - 2 [pause at off (ctr) at least 1 sec] | | Excessive switching speed will cause temporary loss of both power supplies, and alarm reset capability. |
| ALL | MASTER ALARM pb/lt (3) - on, push | 1,3,122 | |
| CMP | C/W PWR - 1 [pause at off (ctr) at least 1 sec] | 2 | Excessive switching speed will cause temporary loss of both power supplies, and alarm reset capability. |
| ALL | MASTER ALARM pb/lt (3) - on, push | 1,3,122 | |
| CMP | C/W LAMP TEST - 1 (hold) | 2 | 1 position is momentary. |
| CDR | MASTER ALARM pb/lt - on | 1 | |
| CMP | lh C/W lt (15) - on | 2 | |
| | C/W NORM - BOOST | | |
| CDR | MASTER ALARM pb/lt - out | 1 | |
| CMP | C/W NORM - NORM | 2 | |
| CDR | MASTER ALARM pb/lt - on | 1 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | C/W LAMP TEST - 2 (hold) | 2 | 2 position is momentary. |
| CDR | | MASTER ALARM pb/lt - out | 1 | |
| CMP | | lh C/W lt (15) - out | 2 | |
| LMP | | MASTER ALARM pb/lt - on | 3 | |
| CMP | | rh C/W lt (20) - on | 2 | |
| | | C/W LAMP TEST - rel | | |
| LMP | | MASTER ALARM pb/lt - out | 3 | |
| CMP | | rh C/W lt (19) - out | 2 | SUIT COMPR C/W light will remain on until compressor is activated. |
| | | C/W NORM - ACK | | |
| | 4.1.2 | EMS PRELAUNCH TESTS | | |
| | 1 | Initial EMS Prep | | |
| CDR | | EMS FUNC - OFF | 1 | |
| | | CAUTION<br>If SPS THRUST lt on, a grd exists on one or both ΔV THRUST sws. | | |
| | | cb EMS (2) - close | 8 | |
| | | Open EMS GTA cover | 1 | A 5/32-inch hex driver is required. |
| | | GTA sw - on (up) | | GTA switch is used during ground operations only. Setting switch on (up) allows EMS calibration for zero G condition. Switch must be set off (down) and door closed before flight. |
| | | EMS MODE - STBY | | |

EMS PRELAUNCH TESTS

<table>
<tr><th>STA/T</th><th>STEP</th><th>PROCEDURE</th><th>PANEL</th><th>REMARKS</th></tr>
<tr><td>CDR</td><td>2</td><td>EMS FUNC - ΔV<br>Adj alphanumeric brightness (option)<br>Wait 5 sec</td><td>1</td><td></td></tr>
<tr><td></td><td>3</td><td>GTA Null Adj<br>EMS MODE - NORM<br>Adj GTA null adj until ΔV/RNG least significant digit changes <1 per 10 sec</td><td></td><td></td></tr>
<tr><td></td><td>4</td><td>EMS FUNC - ΔV SET<br>Slew ΔV ind to +1586.8</td><td></td><td>ΔV/EMS SET switch used both for slewing G-V scroll and for setting ΔV/RNG indicator. Slew speeds executed by ΔV/EMS SET switch are as follows:
<table>
<tr><th></th><th>G-V Display Ft/Sec 1827 Ft/Sec = 1 In. of Scroll</th><th>ΔV RNG Indicator Ft/Sec or Nautical Miles</th></tr>
<tr><td>Slow (soft stop) INCR or DECR</td><td>30 ft/sec/sec = 0.0164 in./sec</td><td>0.25/sec</td></tr>
<tr><td>Fast (hard stop) INCR or DECR</td><td>480 ft/sec/sec = 0.263 in./sec</td><td>127.5/sec</td></tr>
</table>
For negative numbers ΔV/RNG indicator will display a minus sign. No sign will appear for positive numbers.</td></tr>
<tr><td></td><td>5</td><td>EMS FUNC - ΔV TEST<br>SPS THRUST lt - on<br>ΔV ind - decr (10 sec)</td><td></td><td></td></tr>
</table>

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | SPS THRUST lt - out (at ΔV -0.1 fps)<br>ΔV ind - stops at -20.8±20.7 fps<br>EMS MODE - STBY | 1 | |
| | 6 | EMS FUNC - EMS TEST 1 (CCW) (wait 5 sec) | | Test 1 checks lower trip point of .05 G comparator. |
| | | EMS MODE - NORM (wait 10 sec) | | Ten seconds should be allowed to verify no malfunctions. No other light should come on before or after 10 seconds. |
| | | .05 G lt - out<br>SPS THRUST lt - out<br>Lift vctr dn lt - out<br>Lift vctr up lt - out<br>RNG ind - 0.0 NM | | |
| | | Slew scroll until disp index superimposed upon notch at start of next self-test pattern | | EMS scroll reverse slew capability is limited to one inch. |
| | 7 | EMS FUNC - EMS TEST 2 | | Test 2 checks upper trip point of .05 G comparator. No other light should come on before or after 10 seconds. |
| | | Wait 10 sec<br>.05 G lt - on (all others out) | | |
| | 8 | EMS FUNC - EMS TEST 3 | | Test 3 checks corridor verification circuitry associated with lift vector down light (G <.2). |
| | | .05 G lt - on<br>Lift vctr dn lt - on (10 sec after .05 G lt) | | |
| | | Set RNG ind to 58.0±0.0 NM | | For negative numbers RNG indicator will display minus sign in most significant digit. No sign will appear for positive numbers. |

EMS PRELAUNCH TESTS

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | 9 | EMS FUNC - EMS TEST 4 | 1 | Test 4 checks range-to-go integrator circuits, range-to-go indicator, G-servo circuits, and G-V plotter. |
| | | .05 G lt - on (all others out)<br>G-V trace (during 10-sec period) within test pattern<br>After 10 sec, G-V trace stops at lower right corner of test pattern<br>RNG ind (during 10-sec period) counts toward zero<br>After 10 sec, stops at 0.0±0.2 | | |
| | 10 | EMS FUNC - EMS TEST 5 | | Test 5 checks corridor verification circuitry associated with lift vector up light (G >.2). Enables slewing scroll to start of entry pattern. After scroll is set to <37K fps, it is not permissible to return EMS FUNC switch to EMS TEST 5 position (range integrator and scroll sync would be lost). |
| | | .05 G lt - on<br>Lift vctr up lt - on (10 sec after .05 G lt)<br>RNG ind - resets to 0.0 NM<br>Scribe traces vert line ≈9 G to 0.28±0.1 G & stops (trace within test pattern) | | |
| | 11 | Slew scroll until stylus is at 0.28 G tol step of grd test pattern 1 & verify ΔV instructions are visible | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | 12 | EMS FUNC - RNG SET | 1 | |
| | | EMS MODE - STBY | | |
| | | Scribe traces vert line from 0.28 G to 0.0±0.1 G & stops | | |
| | | All lt - out | | |
| | 13 | EMS FUNC - OFF | | |
| | | **WARNING**<br>GTA sw is for grd tests only & must be set off (down) & door closed for proper flt oper of EMS. | | |
| | | GTA sw - off (down) | | |
| | | Close GTA cover | | A 5/32-inch hex driver is required. |
| | 4.1.3 | GLYCOL LOOP CHECKS | | |
| | | Sec Gly Loop Check | | |
| CMP | | GLY TO RAD SEC vlv - NORM | 377 | |
| | | ECS IND sel - SEC | 2 | |
| | | SEC COOL PUMP - AC1 | | |
| | | RAD SEC IN TEMP ind - 60°-97°F | | |
| | | RAD SEC OUT TEMP ind - 60°-70°F (pegged) | | |
| | | SEC GLY EVAP OUT TEMP ind - 60°-75°F (pegged) | | |
| | | SEC GLY EVAP STM PRESS ind - 0.25 psia (pegged) | | |
| | | SEC GLY DISCH PRESS ind - 39-51 psig | | |
| | | SEC ACCUM QTY ind - 30-50% | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | SEC COOL PUMP - AC2 | 2 | |
| | | SEC GLY DISCH PRESS ind - 39-51 psig | | |
| | | SEC COOL PUMP - off (ctr) | | |
| | | ECS IND sel - PRIM | | |
| | | GLY TO RAD SEC vlv - BYP | 377 | |
| | | Prim Gly Loop Activation | | |
| LMP | | GLY PUMPS - 2 AC1 | 4 | |
| CMP | | PRIM GLY DISCH PRESS ind - 37-50 psig | 2 | GSE flow must be temporarily interrupted (3 minutes maximum) for this check. |
| | | PRIM ACCUM QTY ind - 25-50% | | |
| LMP | | GLY PUMPS - 1 AC1 | 4 | |
| CMP | | PRIM GLY DISCH PRESS ind - 37-50 psig | 2 | |
| | | RAD FLOW CONT PWR - PWR | | |
| | | RAD FLOW CONT AUTO - 2 | | |
| | | ECS RAD tb - 2 | | 2 indicates No. 2 flow proportioning valve controlling flow. |
| | | RAD FLOW CONT AUTO - AUTO | | |
| | | ECS RAD tb - gray | | Gray indicates No. 1 flow proportioning valve controlling flow. |
| | | RAD FLOW CONT PWR - off (ctr) | | |
| CDR | | DIRECT O2 vlv - OPEN (CCW), adj for | 7 | |
| CMP | | O2 FLOW ind - 0.4±0.1 lb/hr | 2 | |
| | 4.1.4 | STANDBY INVERTER (NO. 3) CHECK | | |
| LMP | | AC2 RSET - OFF | 3 | |
| | | INV 3 - MNB | | |
| | | INV 2 AC2 - OFF | | |
| | | INV 3 AC2 - on (up) | | Rapid performance of inverter switching sequence may initiate MASTER ALARM pb/lt when alternate inverter is connected to bus. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| LMP | | AC2 RSET - RSET | 3 | RSET position is momentary. Positioning AC1 or 2 RSET switches to RSET and releasing ensures a MASTER ALARM light and tone. Positioning AC1 or 2 RSET switches to center will cause random activation of MASTER ALARM lights and tone. |
| CMP,LMP | | MASTER ALARM pb/lt (2) - on (push) | 3,122 | |
| CMP | | C/W lts (34) - out | 2 | |
| LMP | | AC IND sel - BUS 2, ØA, B, C | 3 | |
| | | AC VOLTS ind - 113-117 vac | | |
| | | AC2 RSET - OFF | | |
| | | INV 3 AC2 - OFF | | |
| | | INV 2 AC2 - on (up) | | Rapid performance of inverter switching sequence may initiate MASTER ALARM pb/lt when alternate inverter connected to bus. |
| | | AC2 RSET - RSET | | RSET position is momentary. Positioning AC1 or 2 RSET switches to RSET and releasing ensures a MASTER ALARM light and tone. Positioning AC1 or 2 RSET switches to center will cause random activation of MASTER ALARM lights and tone. |
| LMP,CMP | | MASTER ALARM pb/lt (2) - on (push) | 3,122 | |
| CMP | | C/W lts (34) - out | 2 | |
| LMP | | INV 3 - OFF | 3 | Inverter 1 powering a-c bus No. 1 and inverter 2 powering a-c bus No. 2. |
| | | AC IND sel - BUS 1 & 2, ØA, B, C | | |
| | | AC VOLTS ind - 113-117 vac | | |
| | 4.1.5 | FC RADIATOR & FLOAT BAG CHECKS | | |
| | | FC Rad Check | | |
| CMP | | cb FC RAD (all) - close | 226 | |
| LMP | | FC RAD tb (all) - gray | 3 | Gray indicates fuel cell radiator panels not bypassing flow. |
| CMP | | cb FC RAD (all) - open | 226 | |

RC RADIATOR & FLOAT BAG CHECKS

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | Float Bag Check | | |
| CDR | | FLOAT BAG (all) - OFF | 8 | Lever lock. |
| | | cb FLOAT BAG (all) - close | | |
| | | FLOAT BAG (all) - VENT | | Lever lock. |
| | | cb FLOAT BAG (all) - open | | |
| | 4.1.6 | LHEB ECS VALVE STATUS | | |
| CMP | | GLY TO RAD SEC vlv - BYP (verify) | 377 | |
| | | PRIM ACCUM FILL vlv - OFF | 379 | |
| | | PRIM GLY ACCUM vlv - open (CCW) | 378 | |
| | | Y-Y strut - retract | | Y-Y strut to be retracted to provide attenuation panel access. |
| | | Open cool cont atten pnl | | Covers panel 382. |
| | | SUIT HT EXCH PRIM GLY - FLOW (CCW) | 382 | |
| | | WARNING<br>SUIT FLOW RELF vlv must remain OFF throughout msn or swelling of $CO_2$-odor absorber filters may result. | | |
| | | SUIT FLOW RELF vlv - OFF | | |
| | | GLY EVAP IN TEMP vlv - MIN (CCW) | | |
| | | SUIT HT EXCH SEC GLY - FLOW | | |
| | | EVAP $H_2O$ CONT (2) - AUTO | | |
| | | $H_2O$ ACCUM (both) - RMTE | | |
| | | Close cool cont atten pnl | | |
| | | Y-Y strut - extd & lock in place | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | Open CO2 cstr atten pnl | | Covers CO2 canisters. |
| | CO2 CSTR DIVERT vlv - ctr | 350 | |
| | Close CO2 cstr atten pnl | | |
| | MN REG (2) - open | 351 | |
| | H2O/GLY TK sel (2) - BOTH | | |
| | EMER CAB PRESS sel - OFF | | |
| | CAB REPRESS vlv - OFF (CCW) | | |
| | WASTE TK SERV vlv - CLOSE | 352 | Servicing fitting is plugged. |
| | PRESS RELF sel - 2 | | |
| | POT TK IN vlv - CLOSE | | Potable water chlorination port capped. |
| | WASTE TK IN vlv - AUTO | | |
| | PRESS EQUAL vlv - CLOSE | Fwd Hatch | |
| | AC UTIL PWR - OFF | 201 | |
| | TUNL VENT vlv - LM/CM $\Delta P$ | 12 | |
| | LM/CM $\Delta P$ ind - 0.0 psid | | |
| | SUIT FLOW vlv (3) - FULL FLOW | 300,301,302 | |
| | PRIM CAB TEMP vlv - COLD (CW) | 303 | |
| | SEC CAB TEMP vlv - MAX COOL (CW) | | |
| | DRINK H2O SUP vlv - OFF | 304 | Drinking water unavailable during launch hold periods. |
| | 4.1.7 LEB & TIMER PANEL 306 | | |
| | UTIL PWR - OFF | 100 | Connector covered. |
| | FLOOD DIM - 1 | | |
| | FLOOD FIXED - OFF | | |
| | G/N OPT PWR - OFF | | |
| | G/N IMU PWR - on (up) | | Guarded. |
| | RNDZ XPNDR PWR - HTR | | |
| | NUMERICS LTS - as desired | | |
| | INTGL LTS - as desired | | |
| | FLOOD LTS - OFF (CCW) | | |

LEB & TIMER PANEL 306

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | MSN TMR - RSET | 306 | RSET position is momentary. |
| | MSN TMR ind - zero | | |
| | MSN TMR - START | | Mission timer will reset to zero and count up at launch. |
| | MSN TMR ind - counting up (verify) | | |
| | EVNT TMR START - STOP, then ctr | | |
| | EVNT TMR RSET - RSET | | RSET position is momentary. |
| | SYS TEST (2) - 5A | 101 | |
| | SYS TEST ind - 1.1-1.9 vdc | | Equivalent to +45° to +75°F nominal SPS oxidizer engine feedline temperature. |
| | SYS TEST (2) - 5B | | Monitors battery relay bus voltage during launch. |
| | RNDZ XPNDR TEST - OPR | | |
| | CM RCS HTRS - OFF | | |
| | WASTE H2O DUMP - HTR A | | |
| | URINE DUMP - HTR A | | |
| | CAUTION<br>OPT ZERO sw must not be moved during prelaunch or inadvertent jett of opt covers could occur. | 122 | |
| | OPT ZERO - ZERO | | |
| | OPT TELTRUN - SLAVE TO SXT | | |
| | OPT MODE - MAN | | |
| | OPT COUPLING - DIR | | |
| | OPT SPEED - LO | | |
| | COND LAMPS - ON | | |
| | UP TLM - ACPT | | |
| | RETCL BRT tw - as req | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | SCI/UTIL PWR - OFF | 163 | Switches are located behind closeout panel and will be set at panel closeout. |
| | SCI PWR - OFF | 162 | |
| | S1 - OFF | 164 | Connector covered. |
| | CRYO AC PWR - on (up) | 181 | |
| | H2 FAN - AUTO | | |
| | O2 FAN - AUTO | | |
| | SM/AC PWR - on (up) | | Supplies ac/dc power to cameras and EM sounder and heater power to pan camera. |
| | DOOR JETT - off (down) | | Guarded. |
| | LOGIC PWR - OFF | | |
| | cb pnl 181 - all closed | | |
| | 4.1.8 RHEB & PANEL 601 | | |
| | cb pnl 225 - all closed except | 225 | |
| | cb HI GAIN ANT (2) - open | | |
| | cb pnl 226 - all closed except | 226 | |
| | cb FC RAD (all) - open | | Prevents inadvertent fuel cell radiator effective area reduction. |
| | cb FC REACS (all) - open | | Fuel cell reactant valve circuit breakers are opened after fuel cell start-up to preclude inadvertent valve closure. |
| | cb COAS/TUNL LTG MNB - open | | |
| | cb pnl 229 - all closed except | 229 | |
| | cb MN REL (2) - open | | |
| | cb O2 VAC ION PUMPS (2) - open | | |
| | MAP CAMR ON tb - gray | 230 | Gray indicates TBD. |
| | MAP CAMR TRACK tb - gray | | Gray indicates TBD. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | MAP CAMR ON - STBY | 230 | Map camera must be in standby during boost, TLI, and SPS thrusting periods. |
| | MAP CAMR TRACK - off (ctr) | | |
| | MAP CAMR IMAGE MTN - OFF | | |
| | GAMMA RAY BOOM DPLY tb - gray | | Gray indicates boom retracted. |
| | GAMMA RAY BOOM JETT tb - gray | | Gray indicates boom retracted and tie-down engaged. |
| | GAMMA RAY BOOM DPLY - off (ctr) | | |
| | GAMMA RAY BOOM JETT - off (down) | | |
| | GAMMA RAY EXP - OFF | | |
| | GAMMA RAY GAIN - SHLD OFF | | |
| | MASS SPECT BOOM DPLY tb - gray | | Gray indicates boom retracted. |
| | MASS SPECT BOOM JETT tb - gray | | Gray indicates boom retracted and tie-down engaged. |
| | MASS SPECT BOOM DPLY - off (ctr) | | |
| | MASS SPECT BOOM JETT - off (down) | | |
| | MASS SPECT EXP - off (ctr) | | |
| | MASS SPECT ION SOURCE - OFF | | |
| | MASS SPECT MULT - LO | | |
| | MASS SPECT DSCRM - LO | | |
| | DATA SYS CAL - off (down) | | |
| | DATA SYS ON - OFF | | |
| | SUB SAT tb - gray | | Gray indicates TBD. |
| | SUB SAT - off (ctr) | | |
| | PAN CAMR OPR tb - gray | | Gray indicates TBD. |
| | PAN CAMR SELF TEST - off (ctr) | | |
| | PAN CAMR MODE - STBY | | Pan camera must be in standby during boost, TLI, and SPS thrusting periods. |
| | PAN CAMR PWR - BOOST | | |
| | X RAY DR DPLY - off (ctr) | | |
| | X RAY EXP - off (ctr) | | |
| | ALPHA RAY - OFF | | |
| | LASER ALTM - OFF | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | cb pnl 250 - all closed except | 250 | |
| | CAUTION<br>cbs BAT BUS A&B TO PYRO BUS (2) should never be closed when cb PYRO A&B/SEQ A&B (2) are closed. Loss of pyro bat pwr could result. | | |
| | cb BAT BUS A&B TO PYRO BUS (2) - open | | |
| | cb BAT C TO BAT BUS A&B (2) - open | | |
| | OVBD DRAIN vlv - OFF | 251 | |
| | BAT VENT vlv - CLOSE | 252 | |
| | WASTE STOW vlv - VENT | | |
| | REPRESS O2 - CLOSE | 601 | |
| 4.1.9 | ORDEAL SWITCH POSITION CHECK | | Assumes that ORDEAL box has been interconnected between FDAIs and EDA during installation, and that prime or backup crews will not be required to connect or disconnect ORDEAL cables to stow or unstow ORDEAL. |
| | CAUTION<br>Before ORDEAL is stowed, or when not being used (whether EARTH/LUNAR sw is in PWR OFF or not), FDAI 1 & 2 sw must be at INRTL. Otherwise, pitch inertial att cannot be displayed by FDAI ball. | | |
| CDR | FDAI sw (both) - INRTL | 13 | |
| | EARTH/LUNAR - PWR OFF | | |
| | ALT SET cont - as desired | | This value to be determined from planned nominal insertion altitudes for each particular mission. |

ORDEAL SWITCH POSITION CHECK

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | LTG - OFF | 13 | |
| | MODE - HOLD/FAST | | |
| | SLEW - ctr | | |
| 4.1.10 | LH COUCH CHECKS | | |
| | THC & RHC - LOCKED | | It is possible to actuate THC clockwise or counter-clockwise while locked. |
| | LH ECS Vlv Stat | | |
| CMP | SRG TK RELF vlv - open (CW) | 375 | |
| | PLVC sw - NORM | 376 | |
| | DEMAND REG sel - BOTH | 380 | |
| | SUIT TEST vlv - OFF | | |
| | SUIT RETURN vlv - close (push) | | |
| | PRIM GLY TO RAD - NORM | 325 | |
| | CAB PRESS RELF vlv (2) - BOOST/ENTR (safety latch off) | | For ground checks, CAB PRESS is the equivalent of flight term CAB PRESS RELF. |
| | GLY RSVR IN vlv - OPEN | 326 | |
| | GLY RSVR OUT vlv - OPEN | | |
| | GLY RSVR BYP vlv - CLOSE | | |
| | SM 02 SUP vlv - ON | | |
| | SRG TK 02 vlv - ON | | |
| | REPRESS PKG vlv - ON | | |
| | LH Side Pnls | | |
| CDR | COAS PWR - OFF | 15 | |
| | UTIL PWR - OFF | | Connector covered. |
| | PL BCN LT - off (ctr) | | |
| | DYE MARKER - off (down) | | Guarded. Verify safety removed. |
| | PL VENT - OFF | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | AUTO RCS (16) - OFF | 8 | |
| | FLOOD DIM - 1 | | |
| | FLOOD FIXED - OFF | | |
| | NUMERICS LTS - as desired | | |
| | FLOOD LTS - as desired | | |
| | INTGL LTS - as desired | | |
| | SECS LOGIC (both) - OFF | | Lever lock. |
| | SECS PYRO ARM (2) - SAFE | | Lever lock with key lock guard. |
| | cb pnl 8 - all closed except | | |
| | cb CM RCS HTRS (both) - open | | |
| | cb FLOAT BAG (all) - open | | |
| | cb SECS LOGIC (2) - open | | |
| | cb SECS ARM (2) - open | | |
| | EDS PWR - OFF | 7 | |
| | **CAUTION**<br>More than 1 hr of contin on-time for TVC SERVO PWR 1 or 2 sw may be detrimental to SPS gmbl actuators. | | |
| | TVC SERVO PWR (both) - OFF | | |
| | FDAI/GPI PWR - BOTH | | |
| | LOGIC 2/3 PWR - on (up) | | |
| | ELEC PWR - GDC/ECA | | |
| | SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | | Powers RJEC -4 vdc bias power supplies. To provide increased reliability, switches should not be set on same bus. |
| | BMAG PWR (both) - WARMUP | | |
| | LH MDC & Pnls 600, 602, 603, & 604 | | |
| | Set ALT index - 3300 | 1 | Value obtained from LCC. |

LH COUCH CHECKS

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | CMC ATT - IMU | 1 | Normally left at IMU position throughout mission. Selection of GDC position causes total attitude display to be lost on both balls. GDC damage will result if GDC position selected and pitch or yaw rate is >5°/sec, or if GDC yaw Euler angle is >80° and <280°. |
| | ACCEL - check (+1 G) | | |
| | FDAI SCALE - 5/1 | | |
| | FDAI SEL - 1/2 | | |
| | FDAI SOURCE - CMC | | |
| | ATT SET - GDC | | |
| | MAN ATT ROLL - RATE CMD | | |
| | MAN ATT PITCH - ACCEL CMD | | |
| | MAN ATT YAW - RATE CMD | | |
| | LIM CYCLE - OFF | | |
| | ATT DBD - MIN | | |
| | RATE - HI | | |
| | THC PWR - on (up) | | For ground checks, TRANS CONTR PWR, ROT CONTR PWR NORM, and ROT CONTR PWR DIR are the equivalent of flight terms THC PWR, RHC PWR NORM, and RHC PWR DIR respectively. |
| | RHC PWR NORM (both) - AC/DC | | |
| | RHC PWR DIR (both) - OFF | | |
| | SC CONT - SCS | | |
| | CMC MODE - FREE | | |
| | BMAG MODE (3) - RATE 2 | | |
| | SPS THRUST - NORM | | Lever lock. |
| | ΔV THRUST (2) - OFF | | Guarded. |
| | SPS GMBL tw (2) - 0 | | |
| | ATT SET tw (3) - R 162°, P 90°, Y 0° | | |
| | SCS TVC (2) - RATE CMD | | |
| | GMBL MOT (4) - OFF | | |
| | ΔV CG - LM/CSM | | Provides reduced gain for SPS thumbwheel control of SCS auto mode IV abort. |

NORMAL BACKUP

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | ELS LOGIC - OFF | 1 | Guarded. |
| | ELS AUTO - AUTO | | |
| | CM RCS LOGIC - OFF | | |
| | CM PRPLNT DUMP - OFF | | Guarded. |
| | CM PRPLNT PURG - off (down) | | Guarded. |
| | IMU CAGE - off (down) | | Guarded. |
| | EMS ROLL - OFF | | |
| | .05 G sw - OFF | | Required at OFF position until .05 G during entry. OFF position powered by LOGIC 2/3 PWR switch. |
| | α/Pc IND sw - α | | |
| | α/Pc ind - zero | | |
| | LV IND/GPI sw - GPI | | |
| | TVC GMBL DR (2) - AUTO | | |
| | EVNT TMR START - ctr | | Event Timer not counting. Timer resets and starts counting automatically when lift-off occurs. Resets and starts counting up in event of abort initiation. |
| | EVNT TMR RSET - up (ctr) | | |
| CMP | SUIT CAB ΔP ind - >+2.0 in. H20 | 2 | |
| | 02 FLOW ind - 0.4±0.1 lb/hr (not pegged) | | DIRECT 02 valve partially open. |
| | PROBE EXTD/REL tb (2) - gray | | Gray indicates probe fully extended or fully retracted. |
| | PROBE (3) - OFF | | PROBE EXTD/REL switch guarded. |
| | EXT RUN/EVA LTS - OFF | | |
| | EXT RNDZ LTS - off (ctr) | | |
| | TUNL LTS - OFF | | |
| | LM PWR - OFF | | |
| | UP TLM CM - ACPT | | UP TLM CM and UP TLM IU switches should be placed to ACPT only as required during updates. |
| | UP TLM IU - BLOCK | | |

LH COUCH CHECKS

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | CM RCS PRESS - off (down) | 2 | Guarded. |
| | SM RCS IND sw - PRPLNT QTY | | |
| | RCS Status Check | | |
| | SM RCS He 1 tb (4) - bp | | Barber pole indicates helium isolation valves for system 1 are closed. |
| | SM RCS He 2 tb (4) - bp | | Barber pole indicates helium isolation valves for system 2 are closed. |
| | SM RCS PRIM PRPLNT tb (4) - bp | | Barber pole indicates at least one primary propellant isolation valve (fuel or oxidizer) in each quad is closed. |
| | SM RCS SEC PRPLNT tb (4) - bp | | Barber pole indicates at least one secondary propellant isolation valve (fuel or oxidizer) in each quad is closed. |
| | SM RCS SEC FUEL PRESS (4) - OPEN | | OPEN position is momentary. There is no position indicator talkback. Valve opening can be confirmed by ACE. |
| | RCS IND sel - SM A, B, C, D | | |
| | SM RCS PKG TEMP ind - amb | | SM RCS heaters are not operated on pad and during ascent to reduce effects of boost heating on package temperature. Ambient temperature <75° or >205°F will illuminate SM RCS status lights. |
| | SM RCS He PRESS ind - 4000-4350 psia | | Nominal He load is 4150 psig at 70°F. Pressure and temperature excursions are due to ambient conditions. |
| | SM RCS SEC FUEL PRESS ind - 192-207 psia | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | SM RCS IND sw - He TK TEMP | 2 | |
| | SM RCS He TK TEMP ind - 60°-80°F | | |
| | SM RCS IND sw - PRPLNT QTY | | |
| | SM RCS PRPLNT QTY ind - 100% | | |
| | SM RCS HTRS (4) - OFF | | |
| | CM RCS PRPLNT (both) - on (up) | | On position is momentary. |
| | CM RCS PRPLNT tb (both) - gray | | Gray indicates propellant isolation valves are open. |
| | RCS IND sel - CM 1, CM 2 | | |
| | CM RCS He TEMP ind - 60°-90°F | | |
| | CM RCS He PRESS ind - 4000-4450 psia | | |
| | CM RCS MANF PRESS ind - 80-105 psia | | GSE servicing pressure monitored until system activated. Pressure varies with temperature and ullage. If manifold pressure drops suddenly (indicates a ruptured burst diaphragm), close CM RCS propellant isolation valves and then preheat jets, 4.15.4, for 15 minutes after orbit insertion. Preheating open vents to vent any propellant trapped between propellant isolation valves and jets by energizing jet valve direct coils. |
| | RCS CMD - ctr | | Switch last set to OFF (momentary position) prior to backup crew ingress. |
| | RCS TRNFR - SM | | SM position is momentary. |
| | EDS AUTO - OFF | | |
| | CSM/LM FNL SEP (both) - off (down) | | Guarded. |
| | CM/SM SEP (2) - off (down) | | Guarded. |
| | SIVB/LM SEP - off (down) | | Guarded. |
| | PRPLNT DUMP - AUTO | | |
| | 2 ENG OUT sw - AUTO | | |
| | LV RATES sw - AUTO | | |
| | TWR JETT (both) - AUTO | | Guarded. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | LV GUID sw - IU | 2 | Guarded. |
| | | LV STAGE - OFF | | Guarded. |
| | | XLUNAR INJECT - INJECT | | |
| | | MN REL - off (down) | | Guarded. |
| | | EMER 02 - CLOSE | 600 | |
| | | REPRESS 02 RELF - open (CW) | 602 | |
| | | REPRESS 02 PRESS ind - >865 psig | | |
| | | EVA STA 02 SUP - OFF | 603 | |
| | | SUIT PRESS ALARM - OFF | 604 | |
| | 4.1.11 | RH COUCH CHECKS | | |
| | | RHEB & Pnl 16 | | |
| LMP | | SCI PWR - OFF | 227 | Connector covered. |
| | | DOCK TRGT - OFF | 16 | Connector covered. |
| | | UTIL PWR - OFF | | Connector covered. |
| | | COAS PWR - OFF | | |
| | | cb pnl 275 - all closed except | 275 | |
| | | cb MNA & B BAT C (2) - open | | |
| | | cb FLT/PL BAT BUS A, B, & BAT C (3) - open | | |
| | | cb pnl 276 - all closed | 276 | |
| | | cb pnl 278 - all closed except | 278 | |
| | | cb UPR SYS COMPR (both) - open | | |
| | | RH Side Pnls | | |
| | | FC 1 PUMPS - AC1 | 5 | |
| | | FC 2 & 3 PUMPS - AC2 | | |
| | | G/N PWR - AC1 | | |
| | | MN BUS TIE (2) - OFF | | |
| | | BAT CHGR - AC1 | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | NONESS BUS - OFF | 5 | |
| | INTGL LTS - OFF | | |
| | FLOOD LTS - OFF | | |
| | FLOOD DIM - 1 | | |
| | FLOOD FIXED - OFF | | |
| | cb pnl 5 - all closed except | | If circuit breaker RAD HTRS OVLD BAT A and/or BAT B trip, or are opened in flight, they should not be closed unless batteries are tied to main bus [MN BUS TIE (2) - on (up)]. This prevents possible disconnect of ECS radiator heaters by false overload signal. |
| | cb NONESS INST - open | | |
| | cb WASTE DUMP HTRS (2) - open | | |
| | SPS GAUGING - AC1 | 4 | |
| | TELCOM GRP 1 - AC1 | | |
| | TELCOM GRP 2 - AC2 | | |
| | GLY PUMPS - 1 AC1 (verify) | | |
| | SUIT COMPR (both) - OFF | | |
| | cb pnl 4 - all closed | | |
| | RH MDC Pnls | | |
| | FC RAD (all) - off (ctr) | 3 | |
| | FC RAD tb (all) - gray | | Gray does not indicate status of fuel cell radiator bypass valves as talkback circuits are not powered at this time. |
| | FC HTRS (all) - on (up) | | |
| | FC PURG (all) - OFF | | |
| | FC REACS (all) - ctr | | |
| | FC REACS tb (all) - gray | | Gray indicates fuel cell reactants valves open. |
| | FC MNA 1 & 3 - OFF, 2 - ctr | | Fuel cell management will be monitored by ground crew until the gimbal drive and trim check at which time they will be verified on the main buses by the crew. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | FC MNA 1 & 3 tb - bp, 2 tb - gray | 3 | Barber pole indicates fuel cells 1 and 3 disconnected from main bus A, gray indicates fuel cell 2 connected to main bus A. |
| | MNA RSET - ctr | | |
| | FC MNB (all) - OFF | | |
| | FC MNB tb (all) - bp | | Barber pole indicates all fuel cells disconnected from main bus B. |
| | MNB RSET - ctr | | |
| | FC IND sel - 1, 2, 3 | | |
| | FC H2 FLOW ind - 0.01-0.05 lb/hr | | Flow limits are proportional to individual fuel cell currents and can be approximated by fuel cell H2 flow ≈(amps x 2.5)/1000, and fuel cell O2 flow ≈(amps x 2.0)/100. GSE is supplying most of the SC power. |
| | FC O2 FLOW ind - 0.1-0.4 lb/hr | | |
| | FC SKIN TEMP ind - 390°-450°F | | |
| | FC COND EXH TEMP ind - 150°-175°F | | |
| | FC tb (2) - gray | | Gray indicates normal pH factor and normal fuel cell radiator temperature. |
| | FC IND sel - 2 | | |
| | BAT CHG - OFF | | |
| | DC IND sel - FC 1, 2, 3 | | |
| | DC AMPS ind - 5-20 amps | | |
| | DC IND sel - MNA, B | | |
| | DC VOLTS ind - 26.5-31 vdc | | |
| | DC IND sel - BAT BUS A, B, BAT C | | |
| | DC VOLTS ind - 35-37.5 vdc | | |
| | DC AMPS ind - <3.0 amps | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | CAUTION<br>Do not leave DC IND sel at PYRO BAT A (B) position any longer than req to read DC VOLTS, or PYRO bat chg will be depleted. | | |
| LMP | DC IND sel - PYRO BAT A, B<br>DC VOLTS ind - 36.0-37.5 vdc<br>DC IND sel - MNA | 3 | |
| | Dual Inv Stat Check<br>INV 1 - MNA<br>INV 2 - MNB<br>INV 3 - OFF<br>INV 1 AC1 - on (up)<br>INV 2 AC1 - OFF<br>INV 3 AC1 - OFF<br>INV 1 AC2 - OFF<br>INV 2 AC2 - on (up)<br>INV 3 AC2 - OFF<br>AC IND sel - BUS 1 & 2, ØA, B, C<br>AC VOLTS ind - 113-117 vac | | Switch position verification only. If switch positions must be changed, refer to 4.5.3.9, step a. |
| | SPS Stat Checks<br>SPS PRPLNT TEMP ind - 100°F max | | Normal operating temperature is +45° to +75°F. Redline is +27 and +100°F. |
| | SPS FUEL PRESS ind - 170-195 psia<br>SPS OXID PRESS ind - 170-195 psia | | Normal operating pressure after fuel and oxidizer tank is pressurized with He (after He valve is actuated) is 170-195 psia. GSE servicing pressure is 110 psia. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | SPS PRESS IND sw - He, N2A, N2B | 3 | |
| | SPS He PRESS ind - 3300-3900 psia | | GSE servicing pressure is 3600±50 psia. |
| | SPS N2 PRESS ind - 2200-2800 psia | | |
| | SPS INJ VLV ind (4) - CLOSE | | |
| | SPS OXID VLV upper tb - MAX (verify) | | Upper talkback MAX and lower talkback gray indicates propellant utilization valve positioned for maximum oxidizer flow. |
| | SPS OXID VLV lower tb - gray (verify) | | |
| | OXID FLOW VLV INCR - INCR (verify) | | Valve positioned to INCR by GSE during hypergolic landing. |
| | OXID FLOW VLV PRIM - PRIM | | |
| | PUG MODE - NORM | | |
| | SPS He VLV tb (both) - bp | | Barber pole indicates both helium isolation valves closed. |
| | SPS He VLV (both) - AUTO | | |
| | SPS LINE HTRS - off (ctr) | | |
| | SPS PRESS IND sw - He | | |
| | VHF ANT - SM LEFT | | |
| | S BD XPNDR - OFF | | |
| | S BD PWR AMPL PRIM - PRIM | | |
| | S BD PWR AMPL HI - off (ctr) | | |
| | S BD MODE VOICE - VOICE | | |
| | S BD MODE PCM - PCM | | |
| | S BD MODE RNG - RNG | | |
| | S BD AUX TAPE - ctr | | |
| | S BD AUX TV - ctr | | |
| | UP TLM DATA - DATA | | |
| | UP TLM CMD - RSET, then OFF | | |
| | PWR AMPL tb - bp | | Barber pole indicates power is not applied to S-band power amplifier. |
| | TAPE MOTION tb - bp | | Barber pole indicates no tape motion. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | S BD ANT OMNI A - B | 3 | |
| | S BD ANT OMNI - OMNI | | |
| | VHF AM SQLCH tw (2) - noise +1 | | |
| | VHF AM (2) - off (ctr) | | |
| | VHF AM RCV - off (ctr) | | |
| | VHF BCN - OFF | | |
| | VHF RNG - OFF | | |
| | S BD SQLCH - ENBL | | |
| | FC REAC VLV - NORM | | |
| | H2 PURG LINE HTR - OFF | | |
| | TAPE RCDR PCM - PCM/ANLG | | |
| | TAPE RCDR RCD - RCD | | Power to switch is provided by the up-data link or the TAPE RCDR FWD switch in FWD position. |
| | TAPE RCDR FWD - REWIND | | Allow tape to completely rewind before proceeding. TAPE MOTION talkback is gray when tape is in motion. |
| | TAPE RCDR FWD - off (ctr) | | |
| | SCE PWR - NORM | | |
| | PMP PWR - NORM | | |
| | PCM BIT RATE - HI | | |
| CMP | MSN TMR - RSET | 2 | RSET position is momentary. |
| | MSN TMR ind - zero | | |
| | MSN TMR - START | | Will reset to zero and count up at lift-off, but not abort initiation. |
| | MSN TMR ind - counting up | | |
| | C/W NORM - ACK | | |
| | C/W CSM - CSM | | |
| | C/W PWR - 1 (verify) | | |
| | C/W LAMP TEST sw - ctr | | |
| | PL VENT VLV - push (lock) | | |
| | CRYO H2 PRESS ind (both) - 225-260 psia | | |

RH COUCH CHECKS

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | O2 PRESS IND sw - SURGE TK | 2 | |
| | CRYO O2 PRESS 1 ind - 865-935 psia | | |
| | O2 PRESS IND sw - TK 1 | | |
| | CRYO O2 PRESS ind (both) - 865-935 psia | | |
| | CRYO H2 QTY ind (both) - 100% | | |
| | CRYO O2 QTY ind (both) - 100% | | |
| | CAB FAN (both) - OFF | | |
| | H2 HTRS (both) - AUTO | | |
| | O2 HTRS (both) - AUTO | | |
| | O2 PRESS IND sw - SURGE TK | | |
| | H2 FANS (both) - AUTO | | |
| | O2 FANS (both) - AUTO | | |
| | ECS IND sel - PRIM | | |
| | RAD PRIM IN TEMP ind - 60°-97°F | | |
| | RAD PRIM OUT TEMP ind - 35°-50°F | | |
| | PRIM GLY EVAP OUT TEMP ind - 35°-50°F | | |
| | PRIM GLY EVAP STM PRESS ind - 0.25 psia (pegged) | | |
| | PRIM GLY DISCH PRESS ind - 60 psig max | | |
| | SUIT TEMP ind - 45°-55°F | | |
| | CAB TEMP ind - 70°-80°F | | |
| | SUIT PRESS ind - ≈14.9 psia | | |
| | CAB PRESS ind - ≈14.7 psia | | |
| | CO2 PP ind - 0.0 mm Hg | | |
| | RAD FLOW CONT AUTO - AUTO | | |
| | ECS RAD tb - gray | | Gray indicates No. 1 flow proportioning valve controlling flow. |
| | RAD FLOW CONT PWR - off (ctr) | | |
| | RAD MAN SEL - RAD 1 | | When switch is powered, by placing RAD FLOW CONT PWR switch to MAN SEL, center position will close all isolation valves. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | RAD PRIM HTR - off (ctr) | 2 | |
| | RAD SEC HTR - OFF | | |
| | SUIT COMPR $\Delta$P ind - 0.0 psid | | SUIT COMPR C/W light remains on as long as compressors are not operating. |
| | PRIM ACCUM QTY ind - 25-50% min | | |
| | H20 QTY IND sw - WASTE | | |
| | WASTE H20 QTY ind - <80% | | |
| | H20 QTY IND sw - POT | | |
| | POT H20 QTY ind - 80% | | |
| | POT H20 HTR - OFF | | |
| | SUIT H20 ACCUM AUTO - ctr | | |
| | SUIT H20 ACCUM ON - ctr | | |
| | SUIT HT EXCH - ON for 20 sec then off (ctr) | | Unless SUIT HT EXCH control switch is positioned to off (center), continuous power will be applied to motor valve. |
| | SEC COOL EVAP - RSET for 58 sec min, then off (ctr) | | Ensures secondary loop steam pressure valve closed. |
| | SEC COOL PUMP - off (ctr) | | |
| | GLY EVAP IN TEMP - MAN | | |
| | Position prim loop stm press vlv | | |
| | GLY EVAP STM AUTO - MAN | | |
| | GLY EVAP STM INCR - INCR for 58 sec min, then DECR for 8.5±0.5 sec | | INCR and DECR positions are momentary. Steam pressure valve requires 58 seconds from full close to full open. |
| | GLY EVAP H20 FLOW - off (ctr) | | |
| | CAB TEMP - MAN | | |
| | CAB TEMP tw - max decr | | |
| | HI GAIN ANT PWR - OFF | | |
| | HI GAIN ANT TRACK - AUTO | | |
| | HI GAIN ANT BEAM - WIDE | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | HI GAIN ANT PITCH ind - +90° | 2 | Power off indicator reading. |
| | | HI GAIN ANT YAW ind - 0° | | Power off indicator reading. |
| | | HI GAIN ANT PITCH cont - 0° | | Stow position. |
| | | HI GAIN ANT YAW cont - 180° | | Stow position. |
| | | HI GAIN ANT SERVO - PRIM | | |
| | | CAB PRESS DUMP vlv - close (CW) | Side hatch | |
| | 4.1.12 | COMMUNICATIONS CHECK | | |
| | 1 | Comm Activation | | |
| LMP | | S BD XPNDR - PRIM | 3 | |
| | | S BD PWR AMPL HI - HI | | |
| | | PWR AMPL tb - gray (after 90 sec) | | Gray indicates power applied to S-band power amplifier. |
| | | VHF AM B - DUPLEX | | |
| CMP | | S BD ANT ind - >1/3 scale | 2 | |
| ALL | | MODE (3) - INTERCOM/PTT | 9,10,6 | |
| | | PAD COMM (3) - T/R | | |
| | | PAD COMM VOL tw (3) - 5 | | |
| | | PWR (3) - AUDIO/TONE | | |
| | | MASTER VOL tw (3) - 5 | | |
| | | SUIT PWR (3) - on (up) | | |
| | | INTERCOM (3) - T/R | | |
| | | INTERCOM VOL tw (3) - 5 | | |
| | | VHF AM (3) - T/R | | |
| | | VHF AM VOL tw (3) - 5 | | |
| | | S BD (3) - T/R | | |
| | | S BD VOL tw (3) - 5 | | |
| | | AUDIO CONT (3) - NORM | | |
| CDR | | VHF RNG - NORM | 9 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 2 | Comm Checks | | |
| CDR,LMP | | Replace facility headsets with CM headsets | | CM headsets and CWG adapters have been connected to communication control head prior to backup crew ingress at which time PWR and SUIT PWR switches were OFF (panels 6, 10, and 9). |
| | | Perform comm checks (pad comm, S-band, & VHF AM) | | |
| CDR | | Return to facility headset | | |
| LMP | | Don CMP headset & perform S-band & VHF AM comm checks | | Ground will switch communication channel such that S-band modes and VHF AM may be verified. |
| | | UP TLM DATA - UP VOICE BU | 3 | |
| | | Establish 2-way comm on S-band | | |
| | | UP TLM DATA - DATA | | |
| | | S BD AUX TAPE - DN VOICE BU | | |
| | | Establish 2-way comm on S-band | | |
| | | S BD AUX TAPE - ctr | | |
| | | Return to facility headset | | |
| | 3 | At Completion of Comm Checks | | |
| ALL | | SUIT PWR (3) - OFF | 9,10,6 | |
| | | PWR (3) - OFF | | |
| CMP | | MASTER VOL tw - 6 | 10 | |
| | | INTERCOM VOL tw - 6 | | |
| | | S BD VOL tw - 6 | | |
| | | VHF AM VOL tw - 7 | | |
| ALL | | Disconnect CM headset & CWG adapter from comm cont head | | |
| CMP | | C/W PWR - off (ctr) | 2 | |
| LMP | | cb C/W (2) - open | 5 | |
| | | CDR & LMP egress CM | | |

COMMUNICATIONS CHECK

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.1.13 VERIFY COUCH CONFIGURATION | | |
| BCMP | MDC assist bar - extd & locked | | Backup CMP (BCMP) accomplishes all tasks in 4.1.13 and 4.1.14. To eliminate confusion, station callouts for CDR and LMP locations have not been included. |
| | Headrests - soft suit position | | |
| | THC armrest in launch position & locked | | |
| | Inbd arm rests - stowed & contr locked | | |
| | Couches - launch/entry position (Y-Y struts extd & locked) | | |
| | Seat pans - 85° position & locked | | |
| | O2/comm umb - stowed | | |
| | Harnesses & restraints - extd & laid aside | | |
| | Couch stab brace - stowed | | |
| | Egress CM | | |
| | 4.1.14 PRIME CREW PRE-INGRESS PROCEDURE | | |
| | Ingress CM | | Backup CMP re-enters CM. |
| | S BD PWR AMPL HI - OFF | 3 | The S-band is powered down to allow GMIL station S-band antenna alignment. |
| | S BD XPNDR - OFF | | |
| | cb C/W (2) - close | 5 | |
| | C/W PWR - 1 | 2 | |
| | MASTER ALARM pb/lt - on, push | 1,3,122 | |
| | Perform Pot Water Chlor | | Performed following launch vehicle propellant loading. |
| | POT TK IN vlv - OPEN | 352 | |
| | Attach needle assy to inj port | | Use carry-on sterilization kit for chlorination. |
| | Insert chlor ampoule into casing | | |
| | Conn knob assy & rot (CW) until piston contacts ampoule | | |
| | Install ampoule assy on needle assy (push & turn CW) | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| BCMP | Rot knob (CW) until ampoule is empty (piston bottoms out) | 352 | Requires ≈5-1/2 turns. |
| | Disconnect ampoule assy from needle assy (push & turn CCW) | | |
| | Rot knob (CCW), remove used ampoule | | |
| | Repeat chlor inj steps using buffer ampoule (do not remove empty ampoule after inj) | | Needle assembly to remain on inject port. |
| | Wait 10 min. Then rot inj barrel (CCW) four turns while holding bayonet section in locked position (CW) | | Withdraws one ampoule of water. |
| | Rot knob (CCW), remove filled ampoule | | |
| | Remove needle assy from inj port | | |
| | Wait 30-45 min. Then withdraw water as follows | | |
| | Attach H20 sampling container to food prep unit H20 probe | | |
| | FOOD PREP HOT H20 vlv - push, rel until 40 oz water withdrawn | 305 | |
| | FOOD PREP COLD H20 vlv - push, rel until 20 oz water withdrawn | | |
| | Remove H20 sampling container from food prep unit & attach to drink gun nozzle | | |
| | DRINK H20 SUP vlv - ON | 304 | |
| | Actuate drink gun cont until 2-4 oz water withdrawn | | |
| | DRINK H20 SUP vlv - OFF | | |
| | Remove H20 sampling container from drink gun nozzle | | |
| | Remove sterilization kit from CM | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| BCMP | DIRECT 02 vlv - OPEN (CCW), adj for | 7 | |
| | 02 FLOW ind - 0.6-0.8 lb/hr | 2 | |
| | SUIT COMPR 1 - AC1 | 4 | |
| | SUIT COMPR lt - out | 2 | |
| | SUIT COMPR ΔP ind - 0.7-0.9 psid | | |
| | SUIT CAB ΔP ind - >+2.0 in. H20 | | |
| | Verify P02 | | |
| | SECS PYRO ARM (2) - SAFE (unlocked) | 8 | Pad safety officer provides key to remove guard from lever lock SECS PYRO ARM switches. |
| | RNDZ XPNDR PWR - OFF | 100 | |
| | S BD XPNDR - PRIM | 3 | |
| | S BD PWR AMPL HI - HI | | |
| | Ingress LEB for prime crew ingress support | | |

## 4.2 PRIME CREW PRELAUNCH CHECKS

### 4.2.1 INGRESS & STATUS CHECKS

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| BCMP | SEC COOL PUMP - may be cycled from AC1 to off (ctr) during crew ingress & checkout to maintain crew comfort | 2 | Activation of secondary loop will warm suit circuit ≈10-15°F. Secondary pump may be selected on or off at option of flight crew for their comfort. Crew may be cold as vehicle is being prechilled by GSE coolant at this time. |

#### 4.2.1.1 CDR Ingress LH Couch

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | Ingress LH couch | | |
| | CDR comm umb - conn to PGA | | |
| | SUIT PWR - on (up) | 9 | |
| | PWR - AUDIO/TONE | | |
| BCMP | lh SUIT FLOW vlv - OFF | 301 | |
| | CDR 02 umb - conn to PGA | | Connect red to red and blue to blue. Suit hose interconnect removed from CM. |
| | lh SUIT FLOW vlv - FULL FLOW | | |
| | CDR 02 vent - shut off & disconnect | | PGA gas connector plugs installed. Ventilator removed from CM. |
| | Assist CDR in position; connections & adjustments completed | | Restraints connected and tightened, and arm rests, torso and life vest adjusted. Helmet protector removed from CM. |
| | Verify sw positions as follows: | | |
| | CAB FAN (both) - on (up) | 2 | |
| CDR | FLOAT BAG (3) - VENT | 8 | Lever lock. |
| | THC - neutral (locked) | | |
| | MAN ATT ROLL - RATE CMD | 1 | |
| | MAN ATT PITCH - ACCEL CMD | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | MAN ATT YAW - RATE CMD | 1 | |
| | | SCS TVC (2) - RATE CMD | | |
| | | $\Delta$V CG - LM/CSM | | |
| | | ELS AUTO - AUTO | | |
| | 4.2.1.2 | LMP Ingress RH Couch | | |
| LMP | | Ingress RH couch | | |
| | | LMP comm umb - conn to PGA | | |
| | | SUIT PWR - on (up) | 6 | |
| | | PWR - AUDIO/TONE | | |
| BCMP | | rh SUIT FLOW vlv - OFF | 300 | |
| | | LMP 02 umb - conn to PGA | | Connect red to red and blue to blue. Suit hose interconnect removed from CM. |
| | | rh SUIT FLOW vlv - FULL FLOW | | |
| | | LMP 02 vent - shut off & disconnect | | PGA gas connector plugs installed. Ventilator removed from CM. |
| | | Assist LMP in position; connections & adjustments completed | | Restraints connected and tightened, and arm rests, torso and life vest adjusted. |
| | | Verify the following | | |
| LMP | | SPS GAUGING - AC1 | 4 | |
| | | GLY PUMPS - 1 AC1 | | |
| | | VHF ANT - SM LEFT | 3 | |
| | | OXID FLOW VLV INCR - NORM | | |
| | | MNA RSET - ctr | | |
| | | MNB RSET - ctr | | |
| | | SPS He VLV (both) - AUTO | | |
| | | S BD ANT OMNI A - B | | |
| | | S BD ANT OMNI - OMNI | | |
| | | VHF BCN - OFF | | |
| | | SCE PWR - NORM | | |
| | | AC 1 RSET - ctr | | |
| | | AC 2 RSET - ctr | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.2.1.3 CMP Ingress Center Couch | | |
| CMP | Ingress ctr couch | | |
| | CMP comm umb - conn to PGA | | |
| BCMP | SUIT PWR - on (up) | 10 | |
| | PWR - AUDIO/TONE | | |
| | ctr SUIT FLOW vlv - OFF | 302 | |
| | CMP 02 umb - conn to PGA | | Connect red to red and blue to blue. Suit hose interconnect removed from CM. |
| | ctr SUIT FLOW vlv - FULL FLOW | | |
| | CMP 02 vent - shut off & disconnect | | PGA gas connector plugs installed. Ventilator removed from CM. |
| | Assist CMP in position; connections & adjustments completed | | Restraints connected and tightened, and arm rests, torso and life vest adjusted. Helmet protector removed from CM. |
| | Perform fnl crew verification | | Helmets, umbilicals, PGA diverter valves and wrist disconnects, foot restraints, and life vests rechecked. |
| | Verify the following | | |
| CMP | PRPLNT DUMP - AUTO | 2 | |
| | C/W NORM - BOOST | | |
| | MSN TMR - START | | |
| | SUIT H20 ACCUM AUTO - 1 | | |
| | SUIT COMPR $\Delta$P ind - 0.7-0.9 psid | | |
| All | VHF AM VOL tw (3) - as desired | 6,10,9 | |
| | S BD VOL tw (3) - as desired | | |
| LMP | UP TLM CMD - NORM | 3 | |
| CMP | UP TLM CM - BLOCK | 2 | |
| BCMP | PAD COMM - OFF | 10 | PAD COMM can be used after launch for intercom backup with PAD COMM VOL thumbwheel decreased. |
| | Egress CM | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.2.1.4 EDS Checkout & Countdown Test | | Crew participation in EDS test is directed by ground personnel. Test requires ≈30 minutes. |
| CDR | cb EDS (3) - close (verify) | 8 | |
| | EDS PWR - on (up) | 7 | |
| CMP | EDS AUTO - on (up) | 2 | |
| CDR | ABORT lt oper - verify | 1 | CDR will verify ABORT light operation as it is activated by ground. |
| LMP | UP TLM CMD - OFF | 3 | |
| CDR | S BD - OFF | 9 | CDR will participate in EDS test on PAD COMM. |
| | INTERCOM - OFF | | |
| | VHF AM - OFF | | |
| LMP | PAD COMM - OFF | 6 | |
| | 4.2.1.5 Cabin Closeout | | |
| -01:40:00 | | | |
| CMP | Side hatch closing | Side hatch | |
| | Verify external tool stowed on outside of hatch (tech) | | |
| | Remove hatch seal protector (tech) | | |
| | Verify safety pin has been removed from actr handle sel (tech) | | |
| | Gear box sel - N (neut) (tech) | | |
| | Actr handle sel - N (neut) (tech) | | |
| | GN2 vlv handle - push (outbd) (tech) | | Squeeze handle to unlock. |
| | Verify piston chamber pressurized | | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | If piston chamber is not pressurized GN2 charge No. 1 - CW (tech) | | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | Hatch open lock - rel (tech) | Side hatch | |
| | | Push hatch to near closed position (tech) | | |
| | | Lock pin rel knob - UNLOCK (verify) | | |
| | | Hold hatch closed | | |
| | | Insert tool B (handle in 9 o'clock position) into external hatch actuation socket, rot CW to stops & hold (tech) | | |
| | | Press & hold LOCK PIN reset button | | |
| | | Relax torque & remove tool B (tech) | | Obtains lock pin engagement. Mechanism should rotate ≈14 inches CCW due to spring pressure. |
| | | LOCK PIN reset button - rel | | |
| | | LOCK PIN ind - not extd (rh couch) &/or white ind is opposite white mrk (ctr & lh couch) | | |
| | | If lock pin is not engaged<br>Insert tool B into external hatch actuation socket & slowly rot CCW until LMP verifies lock pin engagement (tech) | | |
| | | NOTE<br>If RED lock pin is extd ≈0.5 inch, lock pin has been sheared. | | |
| | | GN2 press ind - green (verify) | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | Configure hatch for rapid egress<br>Gear box sel - UNLATCH<br>Actr handle sel - U (unlatch)<br>BPC JETT knob - arrow on knob pointing to BPC JETT decal | Side hatch | |
| -01:35:00 | If rapid hatch opening req, refer to 5.3.1.1 | | |
| | Strut unlock lanyard (2) - unstow & attach handle ends to MDC | | |
| | Grd performs cab purge & hatch leak test<br>Cab purge to 60% 02/40% N2 (launch atmosphere)<br>Grd performs hatch leak test | | GSE verifies 60/40 ratio.<br>Requires ≈20 minutes. |
| | CAUTION<br>During this check, established SUIT/CAB ΔP should be maintained by DIRECT 02 vlv. | | |
| 4.2.1.6 | Change Launch Azimuth (if necessary) | | |
| | Key V78E<br>FL V06 N29<br>X SM launch azimuth XXX.XX DEG<br>Key V21E, load new azimuth<br>PRO | 2 | |
| | CAB FAN (both) - OFF | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.2.1.7 EDS Test Complete | | |
| -01:21:00 | | | |
| | Set cont after test | | |
| CDR | INTERCOM - T/R | 9 | |
| | VHF AM - T/R | | |
| | S BD - T/R | | |
| LMP | PAD COMM - T/R | 6 | |
| CDR | EDS PWR - OFF | 7 | |
| CMP | EDS AUTO - OFF (verify) | 2 | |
| | 2 ENG OUT sw - AUTO (verify) | | |
| | LV RATES sw - AUTO (verify) | | |
| CDR | $\alpha$/Pc ind - ____% | 1 | |
| -01:13:00 | | | |
| CMP | UP TLM IU - BLOCK | 2 | |
| | 4.2.2 FINAL VERIFICATION & SYSTEMS CHECKS | | |
| | 4.2.2.1 G&C Verification | | |
| 1 | Gyro Pwr Up | | |
| | C/W NORM - NORM | | |
| | BMAG TEMP lt (both) - out | | |
| CDR | FDAI/GPI PWR - OFF | 7 | If FDAIs are powered when BMAGs come up to speed, rate needles will oscillate full scale. |
| | ELEC PWR - GDC/ECA | | |
| | BMAG PWR (both) - ON | | |
| | FDAI/GPI PWR - BOTH | | |
| CMP | C/W NORM - ACK | 2 | |
| 2 | GDC Align | | |
| CDR | FDAI SEL - 1 | 1 | |
| | FDAI SOURCE - ATT SET | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | ATT SET tw (3) - R 162°, P 90°, Y 0° | 1 | These are nominal angles for a 72° launch azimuth and agree with prelaunch TCP. Only roll is affected by a variable launch azimuth. |
|  | GDC ALIGN pb - push |  |  |
|  | FDAI 1 - err null |  |  |
|  | ATT SET tw (3) - R 168°, P 81°, Y 355° |  |  |
|  | FDAI 1 - full scale err (verify)<br>R right, P up, Y right |  |  |
|  | FDAI SEL - 2 |  |  |
| CMP | FDAI 2 - ind same as FDAI 1 (verify) | 2 |  |
| CDR | GDC ALIGN pb - push | 1 |  |
| CMP | FDAI 2 - err null | 2 |  |
| CDR | ATT SET tw (3) - R 162°, P 90°, Y 0° | 1 |  |
| CMP | FDAI 2 - full scale err (verify)<br>R left, P down, Y left | 2 |  |
| CDR | FDAI SEL - 1 | 1 |  |
|  | FDAI 1 - ind same as FDAI 2 (verify) |  |  |
|  | GDC ALIGN pb - push |  |  |
|  | FDAI 1 - total att (verify)<br>R 162°, P 90°, Y 0° |  |  |
|  | **WARNING**<br>Sequencers in SECS should be deactivated to preclude an inadvertent abort. |  |  |
|  | SECS PYRO ARM (2) - SAFE (verify) | 8 | Lever lock. |
|  | SECS LOGIC (both) - OFF (verify) |  | Lever lock. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.2.2.2 Gimbal Drive & Trim Check | | Verifies trim control and manual (MTVC) control capability of primary and secondary gimbal control system. SPS gimbal angle settings based on CSM c.g. and vary with propellant loading. |
| | | | PITCH and YAW GMBL caution/warning lights (panel 2) indicate overcurrent to gimbal motors. Otherwise, no indication to crew, except for switch selection, that a gimbal motor not operating or auto switchover (THC-CW) has taken place. |
| | | | GMBL POS indicator response opposite to RHC commands as follows:<br>RHC IND<br>+ Pitch - Pitch<br>- Pitch + Pitch<br>+ Yaw - Yaw<br>- Yaw + Yaw |
| | 1 Initialization<br>FC on mn buses (verify) | | Fuel cells are placed on main buses by crew prior to primary TVC check per ground crew instructions. |
| LMP | FC MNA 1 & 2 - ctr, 3 - OFF<br>FC MNA 1 & 2 tb - gray, 3 tb - bp | 3 | Gray indicates fuel cells 1 and 2 connected to main bus A; barber pole indicates fuel cell 3 disconnected from main bus A. |
| | FC MNB 1 & 2 - OFF, 3 - ctr<br>FC MNB 1 & 2 tb - bp, 3 tb - gray | | Barber pole indicates fuel cells 1 and 2 disconnected from main bus B; gray indicates fuel cell 3 connected to main bus B. |
| | MN BUS TIE (2) - on (up) | 5 | |
| CDR | SCS TVC (2) - RATE CMD (verify) | 1 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | CAUTION<br>More than 1 hr of contin on-time for TVC SERVO PWR 1 or 2 sw may be detrimental to SPS gmbl actuators. | | |
| CDR | | TVC SERVO PWR 1 - AC1/MNA | 7 | |
| | | TVC SERVO PWR 2 - AC2/MNB | | |
| | | LV IND/GPI sw - GPI (verify) | 1 | |
| | | RHC 2 - ARMED | | |
| | 2 | Prim TVC Check | | |
| | | GMBL MOT P1, Y1 - START | | START position is momentary. Start SPS gimbal motors sequentially at ≈1-second intervals to avoid power surge. For ground checks, GMBL MOT PITCH or YAW are the equivalent of flight terms GMBL MOT P or Y. |
| | | Confirm trim cont on inds<br>SPS GMBL tw (2) - + & - | | Gimbals drive in response to SPS pitch and yaw thumbwheel movement. Verifies primary gimbal trim control. |
| | | RHC 2 - perform MTVC check | | Gimbals drive in response to RHC movement, and return to set-in values when RHC is neutral. Verifies primary MTVC loops. |
| | 3 | Sec TVC Check | | |
| | | SCS TVC (2) - AUTO | | |
| | | GMBL MOT P2, Y2 - START | | |
| | | THC - CW | | |
| | | Confirm trim cont on inds<br>SPS GMBL tw (2) - + & - | | Verifies secondary gimbal trim control. |
| | | RHC 2 - perform MTVC check | | Verifies secondary MTVC loops. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4 | Auto Switchover Check | | |
| CDR | | GMBL MOT P2, Y2 - OFF | 1 | Shut off gimbal motors sequentially to avoid a power surge. |
| | | Verify no MTVC | | |
| | | THC - neut | | |
| | | SPS GMBL tw (2) - P___°, Y___° | | Gimbals are trimmed to thrusting values. These values are derived from Operational Trajectory, Table VIIIa, and include gimbal offset of ____ in pitch and ____ in yaw from spacecraft axis. |
| | | GMBL MOT P1, Y1 - OFF | | |
| | | RHC PWR NORM 2 - AC/DC | | |
| | | RHC 2 - LOCKED | | |
| LMP | | MN BUS TIE (2) - OFF, then AUTO | 5 | |
| CDR | | TVC SERVO PWR (both) - OFF | 7 | |
| | | LV IND/GPI sw - SII/SIVB | 1 | |
| | 4.2.2.3 | FDAI Verification | | |
| | | FDAI SEL - 1/2 | | |
| | | FDAI SOURCE - CMC | | |
| | | FDAI 1 - total att<br>R X°; P 90°; Y 0° | | FDAI 2 is drifting as a function of earth rate. |
| | 4.2.2.4 | RSI Test & Setup | | For ground checks, EMS RAI is the equivalent of flight term RSI. |
| | | EMS ROLL - on (up) | | |
| | | GDC ALIGN pb - push & hold | | |
| | | ATT SET YAW tw - adj thru 45° angle, observe RSI tracks ≈45°, then adj until RSI points up | | Avoid FDAI gimbal lock region. |
| | | GDC ALIGN pb - rel | | |
| | | EMS ROLL - OFF | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | Align GDC to IMU | | Ensures that GDC is aligned to actual IMU angles, rather than calculated values. Attitude reference comparison (in orbit) will be more accurate. |
| | FDAI SEL - 1 | 1 | |
| | FDAI SOURCE - ATT SET | | Constraint: If CMC is on, an overload in IMU resolver circuitry may cause an ICDU oscillation and trigger ISS warning light. (Reference ICD MH01-01325-216.) FDAI must be used as a null meter in this mode of operation. If not, large errors will result because of impedance mismatch. |
| | ATT SET - IMU | | |
| | ATT SET tw (3) - null FDAI 1 err | | |
| | ATT SET - GDC | | |
| | GDC ALIGN pb - push | | |
| | FDAI SOURCE - CMC | | |
| | FDAI SEL - 1/2 | | |
| | 4.2.2.5 EMS Prep | | |
| | Set EMS ΔV | | |
| | EMS MODE - STBY (verify) | | |
| | EMS FUNC - ΔV SET | | |
| | Set ΔV ind - 6999.9 fps | | |
| | EMS FUNC - ΔV | | |
| -55:00 | | | |
| CMP | C/W NORM - BOOST | 2 | Inhibits master alarm light on panel 1. |
| LMP | Cont head sw - XMIT, hold until advised to rel | | |
| | UP TLM CMD - NORM | 3 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.2.2.6 Pad Abort Enable | | |
| | WARNING | | |
| | After pad abort enbl, oper of THC - CCW will init an abort. | | |
| -44:00 | | | |
| CDR | EDS PWR - on (up) | 7 | |
| CMP | Gear box sel - LATCH | Side hatch | |
| | Actr handle sel - U (unlatch) (verify) | | |
| ALL | Shoulder harness - locked | | |
| CDR | CM RCS LOGIC - on (up) | 1 | |
| | cb SECS ARM (2) - close | 8 | |
| | cb SECS LOGIC (2) - close | | |
| | SECS LOGIC (both) - on (up) | | Lever lock. |
| | Report logic arm | | |
| | After GO from STC SECS PYRO ARM (2) - on (up) | | Both lever lock pyro arm switches must be operated. LES pad abort capability enabled; SECS LOGIC and PYRO buses are armed. |
| -28:00 | | | |
| CMP | H2 FANS (both) - off (ctr) | 2 | |
| | O2 FANS (both) - off (ctr) | | |
| | 4.2.2.7 SM RCS Activation | | |
| -25:00 | SM RCS He 1 (4) - OPEN | | OPEN position is momentary. |
| | SM RCS He 1 tb (4) - gray | | Gray indicates primary He isolation valves open. |
| | SM RCS He 2 (4) - OPEN | | OPEN position is momentary. |
| | SM RCS He 2 tb (4) - gray | | Gray indicates secondary He isolation valves open. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | RCS IND sel - SM A, B, C, D | 2 | |
| | SM RCS SEC FUEL PRESS ind - 192-207 psia | | Check pressure with RCS IND selector positioned at SM A, B, C, and D (in turn). |
| | SM RCS SEC FUEL PRESS (4) - CLOSE | | CLOSE position is momentary. No talkbacks. ACE can confirm valves closed. |
| | SM RCS PRPLNT (4) - OPEN | | OPEN position is momentary. Opens 16 isolation valves. |
| | SM RCS PRIM PRPLNT tb (4) - gray | | Gray indicates primary fuel and oxidizer isolation valves open. |
| | SM RCS SEC PRPLNT tb (4) - gray | | Gray indicates secondary fuel and oxidizer isolation valves open. |
| 4.2.2.8 | SM RCS Status Check | | |
| | RCS IND sel - SM A, B, C, D | | |
| | SM RCS PKG TEMP ind - amb | | SM RCS heaters are not operated on pad or during ascent to reduce effects of boost heating on package temperature. Ambient temperature <75° or >205°F will cause SM RCS status lights to come on. |
| | SM RCS He PRESS ind - 4000-4350 psia | | Nominal He load 4150 psig at 70°F. Pressure and temperature excursions are due to ambient conditions. |
| | SM RCS SEC FUEL PRESS ind - 192-207 psia | | Primary fuel pressure initially shown for each quad until momentary OPEN position of SM RCS A (B, C, D) SEC FUEL PRESS switch selected. |
| | SM RCS IND sw - He TK TEMP | | |
| | SM RCS He TK TEMP ind - 60°-80°F | | |
| | SM RCS IND sw - PRPLNT QTY | | |
| | SM RCS PRPLNT QTY ind - 100% | | |
| | RCS IND sel - CM 2 | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | **4.2.3 LAUNCH PREPARATION** | | |
| -20:00<br>CMP | Change launch azimuth (if necessary) | | |
| | Key V78E | 2 | |
| | FL V06 N29 | | |
| | X SM launch azimuth XXX.XX DEG | | |
| | Key V21E, load new azimuth | | |
| | PRO | | |
| | Align GDC to IMU, 4.7.3 | | Ensures that GDC is aligned to actual IMU angles, rather than calculated values. Attitude reference comparison (in orbit) will be more accurate. |
| CDR | FDAI SEL - 1 | 1 | |
| | FDAI SOURCE - ATT SET | | Constraint: If CMC is on, an overload in IMU resolver circuitry may cause an ICDU oscillation and trigger ISS warning light. (Reference ICD MH01-01325-216.) FDAI must be used as a null meter in this mode of operation. If not, large errors will result because of impedance mismatch. |
| | ATT SET - IMU | | |
| | ATT SET tw (3) - null FDAI 1 err | | |
| | ATT SET - GDC | | |
| | GDC ALIGN pb - push | | |
| | FDAI SOURCE - CMC | | |
| | FDAI SEL - 1/2 | | |
| | AUTO RCS A/C ROLL (4) - OFF (verify) | 8 | |
| | AUTO RCS B/D ROLL B1 & B2 - MNA | | |
| | AUTO RCS B/D ROLL D1 & D2 - MNB | | |
| | AUTO RCS PITCH A3 & C4 - MNB | | |
| | AUTO RCS PITCH C3 & A4 - MNA | | |
| | AUTO RCS YAW B3 & D4 - MNA | | |
| | AUTO RCS YAW D3 & B4 - MNB | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | BAT C voltage - ___vdc | 3 | |
| | DC IND sel - MNA | | |
| CDR | FDAI 1 - total att<br>R ___°, P ___°, Y ___° | 1 | FDAI 2 is drifting as function of earth rate. |
| | BMAG MODE (3) - RATE 1 | | This position provides most reliable configuration in event a rate gyro fails during boost. |
| | FDAI SCALE - 5/5 | | Roll attitude error is scaled in P11 assuming FDAI is in 50/15/50/10 position. Until this position is selected at +01:50, roll full scale deflection will be 20°, not 5° as position indicates. |
| | RATE - HI | | |
| | RHC (both) - ARMED | | |
| | RHC PWR DIR (both) - MNA/MNB | | |
| | CMC MODE - FREE | | |
| | THC PWR - on (up) | | |
| LMP | S BD - OFF | 6 | |
| CDR | VHF AM - OFF | 9 | |
| ALL | Perform air-to-grd voice check with MCCH | | |
| LMP | S BD - T/R | 6 | |
| CDR | VHF AM - T/R | 9 | |
| | SPS THRUST - NORM | 1 | Lever lock. |
| | ΔV THRUST (2) - OFF | | Guarded. |
| | α/Pc IND sw - α | | |
| CMP | EDS AUTO - on (up) | 2 | |
| | LV RATES sw - AUTO | | |
| | 2 ENG OUT sw - AUTO | | |
| | RCS CMD - OFF | | OFF position is momentary. |
| CDR | TVC SERVO PWR 1 - AC1/MNA | 7 | |
| | TVC SERVO PWR 2 - AC2/MNB | | |
| -10:00 | | | |
| LMP | FC REAC VLVS - LATCH | 3 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| -08:30 | | | |
| CMP | SEC COOL PUMP - off (ctr) | 2 | Crew option may have been exercised to turn SEC COOL PUMP on for crew comfort. |
| -08:00 | Sys stat report | | |
| -06:00 | Sys GO/NO GO for launch | | |
| -04:00 | | | |
| CDR | LV ENG lts (5) - on | 1 | Launch vehicle engine lights on T -04:00 minutes. |
| CMP | P02 (verify) | 2 | |
| | CAUTION<br>Do not press ENTR after keying V75. If ENTR is pressed, G&C sys will receive incorrect liftoff time. | | |
| | Key V75 | | |
| -03:00 | | | |
| LMP | TAPE RCDR FWD - FWD | 3 | |
| | TAPE MOTION tb - gray | | Gray display indicates tape is in motion. |
| -02:15 | | | |
| CDR | PRIM GLY TO RAD - BYP (pull) | 325 | Accomplished immediately after GSE water-glycol pump deactivated (T -02:15). |
| CMP | PRIM GLY DISCH PRESS ind - 37-50 psig | 2 | |
| | PRIM ACCUM QTY ind - 25-50% | | |
| -01:15 | | | |
| LMP | MN BUS TIE (2) - on (up) | 5 | |
| -01:00 | | | |
| CDR,LMP | PAD COMM (2) - OFF | 9,6 | PAD COMM can be used after launch for intercom backup with PAD COMM VOL thumbwheel decreased. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| -00:45 | | | |
| CDR | GDC ALIGN pb - push, hold | 1 | |
| CMP | FDAI 2 total att - no motion | 2 | |
| CDR | GDC ALIGN pb - rel | 1 | |
| | READY FOR IGNITION | | |
| | Refer to Appendix B for cab sw/cont position at veh liftoff. | | |

## 4.3 BOOST AND INSERTION

### 4.3.1 BOOST

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| -00:09 | Ignition | | LV engines lights (5) go on at T -4 min when S-IC indicating circuits are armed. |
| CDR<br>-00:01 | LV ENG lts (5) - out | 1 | Indicates all five engines have achieved over 90 percent of rated thrust. |
| 00:00 | LIFT OFF lt - on &<br>NO AUTO ABORT lt - out | 00:00 | Additional lift-off cues:<br>Event Timer start<br>Voice communications from MSFN<br>DSKY displays Program 11 |
| | **WARNING**<br>Do not press LIFT OFF/NO AUTO ABORT pb if LV RATE or any LV ENG lts on. | MODE 1A | Manual abort initiation may be required. (Refer to mission rules.) |
| | Liftoff verified<br>If LIFTOFF lt off - push<br>If NO AUTO ABORT lt on - push | | Guarded.<br>Guarded. |
| CDR,<br>CMP | Verify EVNT TMR ind resets to zero & starts counting up | RATES<br>±4°/sec P,Y<br>±20°/sec R | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | EVNT TMR START - START | 1 | START position is momentary. |
| CMP | Verify MSN TMR ind resets to zero & starts counting up | 2 | |
| | MSN TMR - RSET/START | | RSET position is momentary. |
| | Verify P11 (auto) | | |
| | No P11 - Key ENTR | MODE 1A | V75 inserted in P02 prior to lift-off. |
| | V06 N62<br>VI XXXXX. FPS<br>H dot XXXXX. FPS<br>H pad XXXX.X NM | | These parameters will be displayed throughout ascent.<br>VI = Inertial velocity.<br>H dot = Altitude rate.<br>H pad = Altitude above pad radius. |
| CDR | If LV RATE & LV GUID lts - on, from T +0 to T +2 min | 1 | |

BOOST

| STA/T STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | LV GUID sw - CMC | | 2 | Allows CMC automatic steering, all stages. |
| | If man cont req<br>Key 46E | MODE 1A | | Disables CMC steering and activates Saturn DAP; RHC provides steering commands to the IU for booster control. These stick commands are discrete rate commands. The attitude error needles are not designed to provide meaningful "fly to" information in the manual mode. |
| CDR<br>+00:12 | Roll prog report | | | |
| | Pitch prog - report | | | |
| +00:30 | Roll prog - complete | | | |
| CMP<br>+00:42 | PRPLNT DUMP - RCS CMD | 00:42 | | |
| | MODE 1B - report | MODE 1B | | |
| CDR<br>+00:50 | Mon α/Pc ind ><br>to T +02:00 | RATES<br>±4°/sec P,Y<br>±20°/sec R | 1 | |
| CMP<br>13K' to 15K' | CAB PRESS ind - starts decr | | 2 | Relieves high CM-to-atmosphere ΔP. Assuming that cabin pressure at lift-off is 14.47 to 14.87 psia, the cabin pressure relief valve could begin modulating at 13K'. |
| | xxxxxxxxxxxxxxxxxxxxxxx<br>x x | | | |
| CDR | If no decr by 25K'<br>rh CAB PRESS RELF vlv - DUMP (safety latch off) until | ATT ERROR<br>±5° P,Y | 325 | |

| STA/T STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | CAB PRESS ind - 8 psia, then NORM (safety latch on) | | 2 | |
| | | MODE 1B | | |
| CMP | If still no decr<br>CAB PRESS DUMP vlv - open (CCW) until CAB PRESS ind - 8 psia, then close (CW) | | Side hatch<br>2 | |
| | xxxxxxxxxxxxxxxxxxxxxxxx | | | |
| +01:21 | MAX Q | 100% AOA<br>5° ROLL<br>error | | |
| CDR<br>+01:56 | MODE 1C - report (R3 = 16.5 NM) | 01:56<br>MODE 1C | | |
| CMP<br>+02:00 | EDS AUTO - OFF<br>2 ENG OUT sw - OFF<br>LV RATES sw - OFF | | | |
| CDR | $\alpha$/Pc IND sw - Pc ←<br>LV RATE lt disabled as platform failure cue & limits changed to 9.2° in P&Y | | 1 | |
| +02:10 | Report GO/NO GO for staging | | | |
| +02:15 | CECO (LV ENG 5 lt - on)<br>LIFT OFF lt - out (CECO +0.6 sec) | | | Center engine cutoff. |

| STA/T STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|
| CDR<br>+02:42 | OECO (LV ENG 1, 2, 3 & 4 lts - on) | | 1 | Outboard engine cutoff. |
| +02:43 | All eng lts - out | | | S-IC/SII separation. |
| | SII/SIVB staging capability armed (OECO +1.4 sec) | | | |
| CMP | xxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>If early SII/SIVB staging req, LV STAGE - on (up)<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | 2 | Guarded. |
| | | MODE 1C | | |
| CDR<br>+02:44 | LV ENG 1, 2, 3, 4 & 5 lts - on | | 1 | SII engine ignition. |
| | SII SEP lt - on | | | SII 2nd plane separation circuitry armed. |
| +02:45 | All eng lts - out | | | SII engines 65 percent rated thrust. |
| CMP | GLY EVAP STM AUTO - AUTO | | 2 | |
| | GLY EVAP H2O FLOW - AUTO | | | |
| CDR<br>+03:13 | SII SEP lt - out | | 1 | SII interstage jettisoned. |
| CMP<br>+03:18 | TWR JETT (both) - on (up) (TFF >1+20) | 03:16<br>MODE II | 2 | Guarded. On position is momentary. |
| | TWR JETT & MODE II report | | | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>No tower jett<br>Go to EMER PROCEDURES, 5.3.2.6<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | | |

| STA/T STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | If LV GUID sw - CMC<br>Key V46E for man cont | MODE II | 2 | Activates Saturn DAP; provides steering commands to the IU for booster control. These stick commands are discrete rate commands. Attitude error needles are not designed to provide meaningful "fly to" information in manual mode. |
| CDR | MAN ATT PITCH - RATE CMD | | 1 | |
| +03:23 | LV guidance init<br>(OECO +41 sec) | | | |
| +03:53 | Guidance good | | | |
| +04:00 | Report status | | | |
| LMP<br>+05:00 | Report status | | | |
| CMP<br>+05:40 | Upstage capability to COI | | | |
| +05:50 | SIVB to orb capability | | | |
| CDR<br>+06:00 | Report status | | | |
| | LV IND/GPI sw - GPI | | | |
| CMP | Mon main bus voltages<br>during gmbl mot start | | 3 | |
| CDR | GMBL MOT (4) - START | | 1 | START position is momentary. Start SPS gimbal motors sequentially at ≈1-second intervals to avoid power surge. |
| | LV IND/GPI sw - SII/SIVB | | | |
| LMP<br>+06:15 | If AZ <96°<br>S BD ANT OMNI - D | | 3 | |
| | If AZ >96°<br>S BD ANT OMNI A - C | MODE II | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | | | |
| +07:00 | Report status<br>MODE II | | |
| +07:42 | CECO (LV ENG 5 lt - on) | 1 | SII center engine cutoff. |
| LMP | | | |
| +08:00 | Report status | | |
| CDR | | | |
| +09:00 | MODE IV report<br>09:00 | | |
| +09:11 | OECO (LV ENG 1, 2, 3 & 4 lts - on)<br>MODE IV | | SII outboard engines cutoff. |
| +09:12 | All eng lts - out | | SII/SIVB separation. |
| CMP | xxxxxxxxxxxxxxxxxxxxxxxxxx<br>x x<br>If no SII/SIVB staging<br>LV STAGE - on (up)<br>x x<br>xxxxxxxxxxxxxxxxxxxxxxxxxx | 2 | Guarded. |
| CDR | | | |
| +09:13 | LV ENG 1 lt - on | 1 | SIVB ignition. |
| +09:16 | LV ENG 1 lt - out | | SIVB thrust to 65 percent. |
| CMP | | | |
| +10:00 | Report/confirm COI<br>MODE IV | | Coast orbital insertion. |
| | 10:08<br>MODE III | | |
| +11:00 | Report status<br>If CMC takeover exercised during thrusting go to backup for SECO | | SIVB cutoff must be manually initiated at a TBD time calculated during the boost. |
| | MODE IV | | |

| STA/T STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | | | |
| +11:29 | SECO | | | SIVB engine cutoff (auto). |
| | LV ENG 1 lt - on | | 1 | |
| CMP | Begin TB5 | | | Time base 5. |
| | | MODE IV | | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxx | | | |
| +TBD | If late SECO | | | |
| | or LV GUID sw - CMC | | 2 | |
| | LV STAGE sw - on (up) | | | Guarded. |
| | SECO | | | |
| CDR | LV ENG 1 lt - on | | 1 | |
| | Begin TB5 | | | |
| | If still no SECO | | | |
| | **WARNING**<br>THC must be returned from CCW position before 3.0 sec or CSM SLA sep will occur. | MODE III | | |
| | THC - CCW, return within 1 sec | | | |
| | SECO | | | |
| | LV ENG 1 lt - on | | | |
| | Begin TB5 | | | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxx | | | |
| +11:39 | INSERTION | INSERTION | | |

| STA/T STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | LV ENG 1 lt - out (SECO +10 sec) | | 1 | |
| | Rcd from DSKY | | 2 | |
| | VI | XXXXX. FPS | | VI = Inertial velocity. |
| | H dot | XXXXX. FPS | | H dot = Altitude rate. |
| | H pad | XXXX.X NM | | H pad = Altitude above pad radius. V82 should not be selected during P02 or P11 within 5 seconds of liftoff time (this applies to any extended verb which sets bit 1 of flagword 4). |
| | (R30, Orbital Parameters) | | | Displays orbital parameters (N44). A meaningful display of N32 and N50 is available only during R30. |
| | Key V82E | | | |
| | FL V16 N44 | | | |
| | Ha | XXXX.X NM | | Ha = Apogee altitude. |
| | Hp | XXXX.X NM | | Hp = Perigee altitude. |
| | TFF | XXBXX MIN-SEC | | TFF = Time of free fall to 49.4 NM (300,000 feet). |
| | Key N50E | | | |
| | Splash err | XXXX.X NM | | Negative for undershoot, positive for overshoot. |
| | Hp | XXXX.X NM | | |
| | TFF | XXBXX MIN-SEC | | |
| | KEY REL | | | |
| | FL V16 N44 | | | |
| | Ha | XXXX.X NM | | |
| | Hp | XXXX.X NM | | |
| | TFF | XXBXX MIN-SEC | | If TFF = -59B59, TF perigee is available by keying N32E. |
| | PRO | | | |

| STA/T | STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|---|
| CMP | | V06 N62 | | 2 | |
| | | VI | XXXXX. FPS | | |
| | | H dot | XXXXX. FPS | | |
| | | H pad | XXXX.X NM | | |
| | | SAFE ORBIT | | | |
| | | Key V37E 00E | | | |

## 4.3.2 POSTORBITAL INSERTION CHECK

### 4.3.2.1 Status Checklist

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | GMBL MOT (4) - OFF | 1 | Shut off gimbal motors sequentially to avoid power surge. Setting No. 2 motors off first minimizes switching in servo logic. |
| LMP | MN BUS TIE (2) - OFF | 5 | |
| CDR | ΔV THRUST (2) - OFF (verify) | 1 | Guarded. |
| | RHC PWR DIR (both) - OFF | | |
| | ELS AUTO - MAN | | |
| | CM RCS LOGIC - OFF | | |
| | cb ELS (2) - open | 8 | |
| | SECS PYRO ARM (2) - SAFE | | Lever lock. |
| | SECS LOGIC (both) - OFF | | Lever lock. |
| | cb SECS ARM (2) - open | | |
| | AUTO RCS (16) - OFF | | |
| | EDS PWR - OFF | 7 | |
| | TVC SERVO PWR (both) - OFF | | |
| LMP | PAN CAMR PWR - off (ctr) | 230 | |
| | PCM BIT RATE - LO | 3 | |
| | FC REAC VLVS - NORM | | Setting switch to NORM removes holding voltage from open side of FC reactant valves. |
| CMP | UP TLM IU - as req | 2 | |
| | SM RCS HTRS (4) - PRIM | | |
| | C/W NORM - NORM | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | WARNING<br>If BPC JETT knob cannot be positioned 180° away from the BPC JETT position before opening side hatch, a pin in the plunger may be sheared possibly allowing press seal to be broken. Cabin repressurization may not be possible due to overboard venting around the BPC plunger. | | |
| CMP | BPC JETT knob - turn arrow on knob 180° away from BPC JETT decal<br>Actr handle sel - N (neut)<br>Vent piston chamber<br>GN2 handle - pull (inbd)<br>GN2 press ind - min | Side hatch | Disarms boost cover hatch release mechanism, preventing BPC JETT plunger from actuating during inflight operation of hatch. |
| ALL | MODE (3) - as desired | 9,10,6 | |
| CMP | Crew couch strut unlock lanyards (2) - stow<br>Couch to docking position<br>Rcd 2-1 data from grd<br>Lat__________ Long__________<br>GETI__________ ΔV__________ | | This data defines landing site and thrusting parameters for a first orbit, deorbit, and entry. |
| CDR | Mon LV TK PRESS ind (4) from orb insertion to CSM/SIVB sep for the following limits<br>$\Delta P < 36$ psid (oxid > fuel)<br>$\Delta P < 26$ psid (fuel > oxid)<br>LV TK PRESS <50 psia | 1 | Refer to mission rules concerning SIVB fuel and oxidizer tank pressures. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.3.2.2 | SCS Attitude Reference Comparison Check, 4.8.2.7 | | Check must be performed as near to orbit injection as possible to prevent additional drift in attitude reference systems. |
| | 4.3.2.3 | SCT/SXT Dust Cover Jett Procedure | | |
| | | **WARNING**<br>**Until optics are to be used, the OPT ZERO (pnl 122), should be kept at ZERO to prevent inadvertent jett of optics covers.** | | |
| CMP | 1 | OPT PWR - on (up) | 100 | |
| | | OPT ZERO - OFF | 122 | Optics zero switch to OFF enables function of OPT MODE and OPT SPEED switches. |
| | | OPT MODE - MAN | | |
| | | OPT COUPLING - DIR | | |
| | | OPT SPEED - HI | | |
| | 2 | OHC - max right<br>Observe ejection thru optics | | Shaft angles for dust cover jettison are SCT = 150° and SXT = 40°. The optics shaft should be driven and maintained at full rate through these angles until covers are jettisoned. |
| | 4.3.2.4 | ECS Postinsertion Configuration | | |
| | | Sec rad leak check | | |
| | | Mon SEC ACCUM QTY ind | 2 | |
| | | GLY TO RAD SEC vlv - NORM for 30 sec, then BYP | 377 | Provides rapid postinsertion pressure integrity check of secondary radiator circuit - verification system has not opened during boost phase. This does not verify coolant loop heat rejection capability as defined in 4.5.4.2, step 7. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | cb PL VENT FLT/PL - open | 8 | Prevents inadvertent opening of postlanding vent valves. |
| | CAB PRESS RELF vlv (2) - NORM (safety latch on) | 325 | |
| LMP | PRIM GLY EVAP STM PRESS ind - 0.09-0.14 psia | 2 | |
| | PRIM GLY EVAP OUT TEMP ind - 38-43°F | | |
| | Init rad flow | | Water-glycol flow through primary loop radiators to commence no sooner than T +30:00 or later than T +55:00. After 2-1/2 minutes of flow, radiator outlet temperature should be less than inlet temperature. |
| CDR | GLY RSVR BYP vlv - OPEN | 326 | |
| | GLY RSVR OUT vlv - CLOSE | | |
| | GLY RSVR IN vlv - CLOSE | | |
| LMP | PRIM ACCUM QTY ind - 25-50% | 2 | |
| CMP,LMP | PRIM ACCUM FILL vlv - ON, until 50% is reached | 379,2 | Primary accumulator quantity reading must be increased by at least 5% to provide ullage in glycol reservoir for temperature excursion. |
| LMP | RAD FLOW CONT PWR - PWR | 2 | |
| CDR | PRIM GLY TO RAD - NORM | 325 | |
| LMP | RAD PRIM HTR - 1 | 2 | |
| | RAD PRIM OUT TEMP ind - below RAD PRIM IN TEMP ind | | |
| | Outlet temp > than inlet after 5 min | | |
| CDR | PRIM GLY TO RAD - BYP (pull), recheck in 10 min | 325 | ECS primary loop radiators again isolated. In 10 minutes, flow through radiators is attempted once more by repeating procedure. |

POSTORBITAL INSERTION CHECK

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | DRINK H2O SUP vlv - ON (CCW) | 304 | |
| LMP | | ECS RAD tb - gray | 2 | Gray indicates No. 1 flow proportioning valve controlling flow. |
| | | POT H2O HTR - MNA | | |
| | | GLY EVAP IN TEMP - AUTO | | |
| | | cb WASTE DUMP HTRS (2) - close | 5 | |
| CDR | | REPRESS PKG vlv - FILL for 10 sec, then OFF | 326 | |
| CMP | | REPRESS O2 PRESS ind - >865 psia | 602 | |
| | 4.3.2.5 | Systems Verification and Monitoring | | |
| | 1 | Mount ORDEAL BOX | 13 | |
| | | Perform ORDEAL Initialization, 4.8.4.8 | | |
| | 2 | Perform C&WS Oper Check, 4.5.5.1 | | |
| | 3 | Perform SM RCS Mon Check, 4.5.2.2 | | |
| | 4 | Perform CM RCS Mon Check, 4.5.2.3 | | |
| CMP,<br>LMP | 5 | Perform EPS Checks, 4.5.3.1 thru 4.5.3.4 | | |
| | 6 | Perform ECS Mon Check, 4.5.4.1 | | |
| LMP | 7 | Perform SPS Mon Check, 4.5.2.1 | | |
| | 8 | cb FC REACS (3) - open (verify) | 226 | |
| | | cb COAS/TUNL LTG MNB - close | | Provides power for right COAS six tunnel lights, and docking spotlight door indicator. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.3.2.6 Cabin Atmosphere Verification | | |
| LMP | 1 | CAB PRESS ind - 5.6-6.2 psia & decr | 2 | Cabin pressure will be 5.6-6.2 psia after launch and continuously decrease until cabin pressure regulator activates and controls pressure to 4.7-5.3 psia. |
| CDR | 2 | DIRECT 02 vlv - close (CW) | 7 | |
| LMP | 3 | 02 FLOW ind - 0.2 lb/hr | 2 | |
| CMP | 4 | EMER CAB PRESS sel - BOTH | 351 | |
| | 5 | SUIT RETURN vlv - open (pull) | 380 | |
| ALL | 6 | Gloves & helmet removed | | |
| CMP | 7 | When CAB PRESS ind <5.3 psia | 2 | |
| | | 02 FLOW ind - 1.0 lb/hr | | |
| | | 02 FLOW HI lt - on | | After 16-second time delay. |
| ALL | | MASTER ALARM pb/lt - on, push | 1,3,122 | |
| | | CAUTION<br>Opening cb ECS PRESS XDUCER 2 MNB to extinguish 02 FLOW HI lt is a crew option. If exercised, the following redundant functions will be lost.<br>CO2 PP ind & C/W circuit<br>CAB PRESS ind<br>02 reg out press (PCM only)<br>GLY EVAP STM PRESS ind<br>02 FLOW ind | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| LMP | 8 | cb ECS PRESS XDUCER 2 MNB - open | 5 | |
| | 9 | 60/40 cab purge complete at 8 hrs after LM isolation following transposition & docking. For 24 hrs after LM isolation following T & D, LM press will be monitored at ≈8-hr intervals using tunl vent vlv in the LM/CM ΔP position. At 24 hrs after LM isolation, it will be determined if a Δ cabin purge is req & the length of this purge. | | |
| CMP | | WASTE STOW vlv - CLOSE | 252 | |
| LMP | | cb ECS PRESS XDUCER 2 MNB - close | 5 | |
| | | 02 FLOW HI lt - out | 2 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.4 INJECTIONS | | |
| | | 4.4.1 TRANSLUNAR INJECTION (TLI) | | |
| | | 4.4.1.1 Thrusting Preparation | | |
| | | CMC - on (req), 4.8.1.3<br>ISS - on and orient known (req), 4.8.1.3 & 4.14<br>SCS - on (req), 4.8.4.2<br>DAP - load & activate (desired), 4.8.2.1<br>Comm Mode - as desired | | Circuit breakers assumed closed except as defined in LIMITED USE CIRCUIT BREAKER list, 4.5.1.2. Alignment to pad orientation unless discrepancy between SIVB IU data and CSM G/N data. |
| CMP | 1 | XLUNAR INJECT - INJECT (verify)<br>If TLI inhibit desired<br>XLUNAR INJECT - SAFE | 2 | TLI inhibit at this point will prevent start of Time Base 6 (TB6). |
| | 2 | If SIVB att cont desired, perform 4.7.1.7 | | SIVB attitude control not affected by TLI inhibit signal. |
| | 3 | Receive IU grd update - ___________<br>UP TLM IU - as req | | |
| | 4 | If req, IMU Realign (P52), 4.14.2 | | |
| CDR | 5 | LM Docking Sys Probe Extension & Stat Check<br>Extd probe<br>cb DOCK PROBE (2) - close (verify) | 8 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | CAUTION<br>PROBE EXTD/REL should not be held in EXTD/REL position longer than 20 sec if probe has not extended. Capability of capture latch rel mots may be degraded. | | |
| CMP | PROBE EXTD/REL - EXTD/REL & hold until probe fully extd<br>PROBE EXTD/REL tb (2) - gray to bp to gray<br>PROBE RETR (2) - OFF (verify) | 2 | Momentary up and guarded. Probe extended by compression spring and attenuator airhead forces. Crew should readily sense by auditory cues that probe has extended when probe bangs against stops. May not see talkbacks go to barber pole because of rapid motion of probe. Barber pole indicates power to talkback through probe circuitry. Return to gray indicates full extension of probe. |
| | PROBE EXTD/REL - RETR | | Guarded. |
| | PROBE EXTD/REL tb (2) - gray (verify) | | Verifies capture latches not locked and probe has started to extend. |

| PROBE POSITION | PROBE EXTD/REL sw & tb positions | |
|---|---|---|
| | EXTD/REL | RETR |
| FULL EXTD | gray | gray |
| FULL RETR | bp | bp |
| PARTIAL EXTD | bp | gray |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 6 | Perform Att Err Disp - Att Set Source, 4.7.2.4 | | |
| CDR | | FDAI/GPI PWR - BOTH | 7 | |
| | 7 | Perform EMS ΔV Test & Null Bias Check, 4.7.6.1, & EMS ΔV Setup, 4.7.6.2 | | |
| | 8 | Set up for CSM/SIVB sep capability | | This step is essentially a return to G&C lift-off configuration for an abort capability. |
| | | Verify/set controls | | |
| CDR,CMP | | RHC (both) - ARM | | |
| CDR | | cb SECS ARM (2) - close | 8 | |
| | | After MSFN AOS | | |
| | | SECS LOGIC (both) - on (up) | | Lever lock. |
| | | Report logic arm after GO from MSFN | | |
| | | SECS PYRO ARM (2) - on (up) | | Lever lock. |
| | | EDS PWR - on (up) | 7 | |
| CMP | | BMAG TEMP lt (2) - out | 2 | |
| CDR | | BMAG PWR (both) - ON | 7 | |
| | | FDAI SCALE - 5/5 | 1 | |
| | | FDAI SEL - 1/2 | | |
| | | THC PWR - on (up) | | |
| | | RHC PWR NORM (both) - AC/DC | | |
| | | RHC PWR DIR (both) - MNA/MNB | | |
| | | BMAG MODE (3) - RATE 1 | | |
| | | SC CONT - SCS | | |
| | | AUTO RCS A/C ROLL (4) - OFF | 8 | |
| | | AUTO RCS B/D ROLL (4) - MNA | | |
| | | AUTO RCS PITCH (4) - MNA | | |
| | | AUTO RCS YAW (4) - MNA | | |
| | | LV IND/GPI sw - SII/SIVB (verify) | | |
| CMP | | LV GUID sw - IU | 2 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | UP TLM CM - BLOCK | 2 | |
| | UP TLM IU - as req | | |
| CDR | Monitor LV TK PRESS ind (4) | 1 | |
| | ΔP <36 psid (oxid > fuel) | | Refer to mission rules concerning SIVB fuel and oxidizer tank pressure. |
| | ΔP <26 psid (fuel > oxid) | | |
| | LV TK PRESS <50 psia | | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>x x | | |
| | If ΔP or LV tank press exceeded | | |
| | TVC SERVO PWR 1 - AC1/MNA | 7 | |
| | TVC SERVO PWR 2 - AC2/MNB | | |
| 00:00 | THC - CCW (4 sec) | | CSM/LV separation. |
| LMP | MN BUS TIE (2) - on (up) | 5 | |
| CDR | BMAG MODE (3) - ATT 1/RATE 2 | 1 | |
| | GMBL MOT P1 & Y1 - START | | START position is momentary. Start SPS gimbal motors sequentially at ≈1-second intervals to avoid power surge. |
| | GMBL MOT P2 & Y2 - START | | |
| 00:04 | THC - neut & +X | | |
| | ΔV THRUST A - NORM | | |
| 00:06 | THRUST ON pb - push | | SPS ignition. |
| | THC - rel (+X off) | | |
| 00:11 | ΔV THRUST A - OFF | | Guarded. |
| | x x<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| +02:37:42 | | | |
| | Monitor for SIVB TB6 | | TB6 may begin after GET 02:34:00. |
| CMP | TB6 strt via CMC | | |
| | V37E 15E | 2 | Configures CMC for TB6 initiation backup. |

| STA/T | STEP PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | FL V16 N35<br>Time to evnt 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | 2 | Time from now to TB6 initiation. Display negative and counts to zero. |
| | EVNT TMR START - STOP<br>Set evnt tmr to 50:59 | | Prepares Event Timer to count up. |
| | SII SEP lt - on (TIG -9 min 38 sec)<br>UPLINK ACTY lt - on | | Indicates start of TB6.<br>Indicates CMC TB6 initiation discrete set. |
| | xxxxxxxxxxxxxxxxxxxxx<br>x x<br>SII SEP lt not on<br>LV GUID - CMC<br>SII SEP lt - on<br>x x<br>xxxxxxxxxxxxxxxxxxxxx | | Applies CMC TB6 discrete to IU. |
| | FL V16 N35<br>Time from evnt 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEL | | Display positive and counts from zero. |
| | UPLINK ACTY lt - out<br>FL V37<br>Key XXE | | Goes out when N35 = 10 seconds.<br>R00. |
| | If TLI inhibit desired<br>XLUNAR INJECT - SAFE | | If switching is done between start of TB6 and TB6 +41 seconds. Switching after TB6 +41 seconds will be honored at TB6 +8 minutes 17 seconds. Inhibiting will cause recycle back into TB5 for countdown to point of second opportunity. |

| STA/T | STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|---|
| | | CAUTION<br>If emer CSM/SIVB sep desired after strt of TB6, without restrt of SIVB, XLUNAR INJECT sw must be in SAFE & read by the LVDC at either TB6 +41 sec or at anytime from TB6 +8 min 17 sec to TB6 +9 min 20 sec before physical CSM/SIVB sep. | | | State of XLUNAR INJECT switch automatically transfers from SAFE to INJECT at CSM/SIVB separation. |
| CDR | | SII SEP lt - out (TIG -9 min 1 sec) | | 1 | |
| 50:59 | | EVNT TMR START - START | | | |
| | 9 | Perform GDC ALIGN, 4.7.3 | | | |
| | | Perform Cryo 02 & H2 Man Fan Oper, 4.5.3.10 | | | |
| LMP | | PCM BIT RATE - HI | | 3 | |
| | | TAPE RCDR FWD - FWD | | | |
| | | UP TLM CMD - RSET | | | |
| 58:00 | | | | | |
| CMP | 10 | Key V37E 47E (thrust mon) | | 2 | |
| | | Poss PROG alarm (4.8.1.16) | | | R02. |
| | | FL V16 N83 | | | |
| | | ΔVX, Y, Z (cont) | XXXX.X FPS | | |
| | | Key N62E | | | |
| | | VI | XXXXX. FPS | | |
| | | H dot | XXXXX. FPS | | |
| | | H pad | XXXX.X NM | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR<br>58:36 | | SII SEP lt - on (TIG -1 min 24 sec) | 1 | |
| 58:38 | | SIVB ullage begins (TIG -1 min 22 sec) | | |
| | | **WARNING**<br>TLI inhibit signals will not be honored after 59:42 (TB6 +9 min 20 sec). | | |
| 59:16<br>CMP | | If TLI inhibit desired<br>XLUNAR INJECT - SAFE | 2 | TLI inhibit signals received between TB6 +8 minutes 17 seconds and TB6 +9 minutes 20 seconds will be honored ≈1 second after receipt. If inhibit signal received during this time, recycle back into TB5 will occur and countdown to point of second opportunity will commence. |
| | 11 | Activate TVC | | |
| CDR | | TVC SERVO PWR 1 - AC1/MNA | 7 | |
| 59:42 | | SII SEP lt - out (TIG -18 sec) | 1 | SII SEP light off at this point indicates 18 seconds from SIVB restart. TLI inhibit is ignored from this point on. |
| | | **WARNING**<br>If emer CSM/SIVB sep is performed after SII SEP lt - out (59:42), TB6 will continue to run with SIVB restrt occurring at 00:00. | | |
| ALL | 12 | Ready for TLI | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | 13 | EMS MODE - NORM | 1 | |
| 59:52 | | SIVB fuel lead | | |
| 59:55 | | SIVB ullage discontinues | | |
| 59:59 | | LV ENG 1 lt - on | | |
| | 4.4.1.2 | TLI Thrusting | | |
| 00:00 | | SIVB restrt (TB6 +9 min 38 sec) | | SIVB engine ignition. |
| 00:02 | | LV ENG 1 lt - out<br>Mon SIVB burn<br>LV TK PRESS ind (4)<br>ΔP <36 psid (oxid > fuel)<br>ΔP <26 psid (fuel > oxid) | | SIVB engine 65 percent rated thrust. |
| | | If CMC takeover exercised during thrusting, go to backup for SECO | | SIVB engine cutoff must be manually initiated at a TBD time calculated during boost. |
| 05:45 | | Mon SECO<br>LV ENG 1 lt - on<br>Report cutoff | | SIVB engine cutoff. TB7 begins. |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>x x<br>If late SECO<br>or LV GUID sw - CMC<br>LV STAGE sw - on (up)<br>SECO<br>LV ENG 1 lt - on<br>Report cutoff | | Guarded. |

TRANSLUNAR INJECTIONS (TLI)

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | If still no SECO | | |
| | WARNING | | |
| | THC must be returned from CCW position before 3.0 sec or CSM SLA sep will occur. | | |
| | THC - CCW, return within 1 sec | | |
| | SECO<br>LV ENG 1 lt - on<br>Report cutoff | 1 | |
| | x xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx x | | |
| 05:55 | LV ENG 1 lt - out (SECO +10 sec) | | |
| | 4.4.1.3 Post-TLI Activities | | |
| 1 | EMS MODE - STBY | | |
| CMP 2 | Record ΔV | | |
| CDR 3 | EMS FUNC - OFF | | |
| LMP 4 | TAPE RCDR FWD - off (ctr)<br>PCM BIT RATE - LO | 3 | |
| 5 | Check orb param (R30) | | |
| CMP | Key V82E | 2 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP |  | FL V16 N44 | 2 |  |
|  |  | Ha XXXX.X NM |  | Altitude above launch pad radius. |
|  |  | Hp XXXX.X NM |  |  |
|  |  | TFF XXBXX MIN-SEC |  | TFF = Time of free fall to 49.4 NM (300,000 ft) above launch pad radius. |
|  |  | PRO (exit R30) |  |  |
|  | 6 | FL V16 N83 |  | P47 display. |
|  |  | ΔVX, Y, Z (cont) XXXX.X FPS |  |  |
|  |  | PRO |  |  |
|  |  | FL V37 |  | To exit P47 when desired. |
|  |  | Key XXE |  |  |
|  | 7 | Perform Postorb Insertion Status Checklist, 4.3.2.1 |  |  |
|  | 8 | Pan & Map Camr Stby Mode off |  |  |
| LMP |  | PAN CAMR PWR - off (ctr) | 230 |  |
|  |  | MAP CAMR ON - OFF |  |  |
| CMP |  | SM/AC PWR - OFF | 181 |  |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 4.4.2 | LUNAR ORBIT INSERTION (LOI) | | |
| | For LOI go to Thrusting, 4.13 | | |
| 4.4.3 | TRANSEARTH INJECTION (TEI) | | |
| | For TEI go to Thrusting, 4.13 | | |

## 4.5 SYSTEMS MANAGEMENT

Systems management is a compilation of data and procedures that are common to more than one mission phase. The procedures involve system monitoring, periodic checks, and unique functions of the following systems only: SPS, RCS, EPS, ECS, C&WS, T/C and Mechanical. Systems integrated procedures for prelaunch through postlanding phases will repeatedly reference material contained in systems management.

### 4.5.1 GENERAL DATA

This paragraph contains information of a general nature that closely relates with Systems Management procedures.

### 4.5.1.1 Systems Test Indicator Readouts

A SYS TEST indicator and two selector switches (panel 101) provide the crew with the capability of monitoring some systems measurements telemetered to MSFN. A chart (figure 4.5-1) for converting the SYS TEST indicator readings to measurement parameters is included in this paragraph. Measurements consist of the following:

- Fuel cells 1, 2, and 3 regulated O2 and H2 pressures
- Fuel cells 1, 2, and 3 radiator outlet temperatures
- O2 and H2 tank 3 quantities and pressures
- Battery compartment manifold pressure
- Battery relay bus voltage
- CSM to LM current
- SPS oxidizer line temperature
- CM/RCS jet injector temperature
- Rendezvous radar transponder voltages and frequency lockup.

The systems test indicator conversion chart (figure 4.5-1) lists positions of the SYS TEST switches (2), and pertinent data available for each indicator readout.

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- Rendezvous radar transponder voltages and frequency lockup.

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| SYS TEST Sel Sw (2) Position | SYS TEST Ind | | | | |
|---|---|---|---|---|---|
| | System | | Sensor Range | Nominal Range | |
| | Function | Measurement No. | | System | Display (volts) |
| 1D | FC 1 02 REG PRESS | SC 2066 P | Zero/75 psia | 58 - 69 psia | 3.9 - 4.6 |
| 2A | FC 2 02 REG PRESS | SC 2067 P | Zero/75 psia | 58 - 69 psia | 3.9 - 4.6 |
| 2B | FC 3 02 REG PRESS | SC 2068 P | Zero/75 psia | 58 - 69 psia | 3.9 - 4.6 |
| 2C | FC 1 H2 REG PRESS | SC 2069 P | Zero/75 psia | 57 - 67 psia | 3.8 - 4.5 |
| 2D | FC 2 H2 REG PRESS | SC 2070 P | Zero/75 psia | 57 - 67 psia | 3.8 - 4.5 |
| 3A | FC 3 H2 REG PRESS | SC 2071 P | Zero/75 psia | 57 - 67 psia | 3.8 - 4.5 |
| 3B | FC 1 RAD OUT TEMP | SC 2087 T | -50/+300°F | -10 - +90°F | 0.6 - 2.0 |
| 3C | FC 2 RAD OUT TEMP | SC 2088 T | -50/+300°F | -10 - +90°F | 0.6 - 2.0 |
| 3D | FC 3 RAD OUT TEMP | SC 2089 T | -50/+300°F | -10 - +90°F | 0.6 - 2.0 |
| 4A | 02 TK 3 QTY | SC 0051 Q | Zero/100% | 0 - 100% | 0.0 - 5.0 |
| 4B | 02 TK 3 PRESS | SC 0053 P | 50 - 1050 psia | 865 - 935 psia | 4.1 - 4.4 |
| 4C | H2 TK 3 QTY | SC 0050 Q | Zero/100% | 0 - 100% | 0.0 - 5.0 |
| 4D | H2 TK 3 PRESS | SC 0052 P | Zero/350 psia | 225 - 265 psia | 3.2 - 3.8 |
| 5A | SPS OXID LINE TEMP | SP 0049 T | Zero/+200°F | +45 - +75°F | 1.1 - 1.9 |

Figure 4.5-1. Systems Test Indicator Conversion Chart (Sheet 1 of 3)

| SYS TEST Sel Sw (2) Position | SYS TEST Ind | | | | |
|---|---|---|---|---|---|
| | System | | Sensor Range | Nominal Range | |
| | Function | Measurement No. | | System | Display (volts) |
| 1A | FC 1 N2 REG PRESS | SC 2060 P | Zero/75 psia | 50 - 58 psia | 3.3 - 3.9 |
| 1B | FC 2 N2 REG PRESS | SC 2061 P | Zero/75 psia | 50 - 58 psia | 3.3 - 3.9 |
| 1C | FC 3 N2 REG PRESS | SC 2062 P | Zero/75 psia | 50 - 58 psia | 3.3 - 3.9 |
| 1D | FC 1 02 REG PRESS | SC 2066 P | Zero/75 psia | 58 - 69 psia | 3.9 - 4.6 |
| 2A | FC 2 02 REG PRESS | SC 2067 P | Zero/75 psia | 58 - 69 psia | 3.9 - 4.6 |
| 2B | FC 3 02 REG PRESS | SC 2068 P | Zero/75 psia | 58 - 69 psia | 3.9 - 4.6 |
| 2C | FC 1 H2 REG PRESS | SC 2069 P | Zero/75 psia | 57 - 67 psia | 3.8 - 4.5 |
| 2D | FC 2 H2 REG PRESS | SC 2070 P | Zero/75 psia | 57 - 67 psia | 3.8 - 4.5 |
| 3A | FC 3 H2 REG PRESS | SC 2071 P | Zero/75 psia | 57 - 67 psia | 3.8 - 4.5 |
| 3B | FC 1 RAD OUT TEMP | SC 2087 T | -50/+300°F | -10 - +90°F | 0.6 - 2.0 |
| 3C | FC 2 RAD OUT TEMP | SC 2088 T | -50/+300°F | -10 - +90°F | 0.6 - 2.0 |
| 3D | FC 3 RAD OUT TEMP | SC 2089 T | -50/+300°F | -10 - +90°F | 0.6 - 2.0 |
| 4A | 02 TK 3 QTY | SC 0051 Q | Zero/100% | 0 - 100% | 0.0 - 5.0 |
| 4B | 02 TK 3 PRESS | SC 0053 P | 50 - 1050 psia | 865 - 935 psia | 4.1 - 4.4 |
| 4C | H2 TK 3 QTY | SC 0050 Q | Zero/100% | 0 - 100% | 0.0 - 5.0 |
| 4D | H2 TK 3 PRESS | SC 0052 P | Zero/350 psia | 225 - 265 psia | 3.2 - 3.8 |
| 5A | SPS OXID LINE TEMP | SP 0049 T | Zero/+200°F | +45 - +75°F | 1.1 - 1.9 |

Figure 4.5-1. Systems Test Indicator Conversion Chart (Sheet 1 of 3)

| SYS TEST Sel Sw (2) Position | SYS TEST Ind | | | | |
|---|---|---|---|---|---|
| | System | | | Nominal Range | |
| | Function | Measurement No. | Sensor Range | System | Display (volts) |
| 5B | BAT RLY BUS VOLT | CC 0232 V | Zero/+45 vdc | 30.5-37 vdc | 3.4 - 4.1 |
| 5C | CM RCS INJ TEMP 24 | CR 2110 T | -50/+50°F | >28°F | >3.9 |
| 5D | CM RCS INJ TEMP 25 | CR 2116 T | -50/+50°F | >28°F | >3.9 |
| 6A | CM RCS INJ TEMP 12 | CR 2114 T | -50/+50°F | >28°F | >3.9 |
| 6B | CM RCS INJ TEMP 14 | CR 2100 T | -50/+50°F | >28°F | >3.9 |
| 6C | CM RCS INJ TEMP 16 | CR 2103 T | -50/+50°F | >28°F | >3.9 |
| 6D | CM RCS INJ TEMP 21 | CR 2119 T | -50/+50°F | >28°F | >3.9 |
| 7A | BAT COMPT PRESS | CC 0188 P | Zero/20 psia | <1 psia | <0.2 |
| 7D | CSM TO LM CURRENT | CC 2962 C | Zero/10 amps | 1.0-6.4 amp | 0.5 - 3.2 |
| XPNDR A | PWR OUTPUT | ST 0711 V | 0 - 0.48W | >0.24W | >1.0 |
| XPNDR B | AGC SIGNAL | ST 0710 V | STIMULUS<br>-115 -25 DBM | TEST<br>OPERATE | >1.0<br>0.0 - 4.5 |
| XPNDR C | PHASE LOCKUP | ST 0712 X | 4.0 - 5.0V<br>0.0 - 0.8V | LOCKED<br>UNLOCKED | >4.0<br><0.8 |
| XPNDR D | OPEN | NONE | | | |

Figure 4.5-1. Systems Test Indicator Conversion Chart (Sheet 2 of 3)

| SYS TEST Ind Display | N2*, O2, H2 Press (psia) | EPS Rad Out Temp (°F) | O2, H2 Tk 3 Qty (%) | O2 Tk 3 Press (psia) | H2 Tk 3 Press (psia) | SPS Oxid Line Temp (°F) | Bat Rly Bus (vdc) | CM RCS Inj Temp (°F) | Bat Compt Manf Press (psia) | LM Power (amps) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0 | -50 | 0 | 50 | 0 | 0 | 0.0 | -50 | 0.0 | 0.0 |
| 0.2 | 3 | -36 | 4 | 90 | 14 | 8 | 1.8 | -46 | 0.8 | 0.4 |
| 0.4 | 6 | -22 | 8 | 130 | 28 | 16 | 3.6 | -42 | 1.6 | 0.8 |
| 0.6 | 9 | -8 | 12 | 170 | 42 | 24 | 5.4 | -38 | 2.4 | 1.2 |
| 0.8 | 12 | +6 | 16 | 210 | 56 | 32 | 7.2 | -34 | 3.2 | 1.6 |
| 1.0 | 15 | +20 | 20 | 250 | 70 | 40 | 9.0 | -30 | 4.0 | 2.0 |
| 1.2 | 18 | +34 | 24 | 290 | 84 | 48 | 10.8 | -26 | 4.8 | 2.4 |
| 1.4 | 21 | +48 | 28 | 330 | 98 | 56 | 12.6 | -22 | 5.6 | 2.8 |
| 1.6 | 24 | +62 | 32 | 370 | 112 | 64 | 14.4 | -18 | 6.4 | 3.2 |
| 1.8 | 27 | +76 | 36 | 410 | 126 | 72 | 16.2 | -14 | 7.2 | 3.6 |
| 2.0 | 30 | +90 | 40 | 450 | 140 | 80 | 18.0 | -10 | 8.0 | 4.0 |
| 2.2 | 33 | +104 | 44 | 490 | 154 | 88 | 19.8 | -6 | 8.8 | 4.4 |
| 2.4 | 36 | +118 | 48 | 530 | 168 | 96 | 21.6 | -2 | 9.6 | 4.8 |
| 2.6 | 39 | +132 | 52 | 570 | 182 | 104 | 23.4 | +2 | 10.4 | 5.2 |
| 2.8 | 42 | +146 | 56 | 610 | 196 | 112 | 25.2 | +6 | 11.2 | 5.6 |
| 3.0 | 45 | +160 | 60 | 650 | 210 | 120 | 27.0 | +10 | 12.0 | 6.0 |
| 3.2 | 48 | +174 | 64 | 690 | 224 | 128 | 28.8 | +14 | 12.8 | 6.4 |
| 3.4 | 51 | +188 | 68 | 730 | 238 | 136 | 30.6 | +18 | 13.6 | 6.8 |
| 3.6 | 54 | +202 | 72 | 770 | 252 | 144 | 32.4 | +22 | 14.4 | 7.2 |
| 3.8 | 57 | +216 | 76 | 810 | 266 | 152 | 34.2 | +26 | 15.2 | 7.6 |
| 4.0 | 60 | +230 | 80 | 850 | 280 | 160 | 36.0 | +30 | 16.0 | 8.0 |
| 4.2 | 63 | +244 | 84 | 890 | 294 | 168 | 37.8 | +34 | 16.8 | 8.4 |
| 4.4 | 66 | +258 | 88 | 930 | 308 | 176 | 39.6 | +38 | 17.6 | 8.8 |
| 4.6 | 69 | +272 | 92 | 970 | 322 | 184 | 41.4 | +42 | 18.4 | 9.2 |
| 4.8 | 72 | +286 | 96 | 1010 | 336 | 192 | 43.2 | +46 | 19.2 | 9.6 |
| 5.0 | 75 | +300 | 100 | 1050 | 350 | 200 | 45.0 | +50 | 20.0 | 10.0 |

*N2 measurements not applicable to CSM 112.

Figure 4.5-1. Systems Test Indicator Conversion Chart (Sheet 3 of 3)

### 4.5.1.2 Limited Use Circuit Breakers

The following list defines circuit breakers which will be open during major portions of flight time. Primary considerations are to maintain maximum crew safety, reduce consumable usage, and increase equipment reliability.

| Circuit Breakers | Panel Location | When Opened | When Closed | Remarks |
|---|---|---|---|---|
| NONESS INST | 5 | Prelaunch | When required | No requirements are defined for use of this circuit breaker at the present time. |
| RAD HTRS OVLD (2) | 5 | CM/SM separation | Prelaunch | If opened in flight, do not reset unless batteries are tied to main buses. This prevents possible disconnect of ECS radiator heaters by a false overload signal. |
| FLOAT BAG (all) | 8 | Prelaunch | After splashdown | Opened to ensure against inadvertent activation of float bag compressors and sea dye marker. |
| CM RCS HTRS (both) | 8 | Prelaunch | Prior to deorbit and entry if heating required | Opened to ensure against inadvertent CM RCS jet activation. Heating probably not required. |
| ELS/CM SM SEP (2) | 8 | Postorbital insertion check | Prior to deorbit and entry | Opened to isolate ELS and CM SM SEP function until needed. |
| PL VENT FLT/PL | 8 | Postorbital insertion check | After splashdown | Opened to ensure against inadvertent activation of postlanding vents. |

| Circuit Breakers | Panel Location | When Opened | When Closed | Remarks |
|---|---|---|---|---|
| SECS ARM (2) | 8 | Postorbital insertion check | During prelaunch, launch, docking, deorbit and entry procedures | Opened to ensure against inadvertent activation of SECS functions. |
| RCS LOGIC (2) | 8 | Post S-IVB separation check | During prelaunch, launch, deorbit, and entry procedures | Opened to ensure against inadvertent CM/SM RCS transfer and/or CM RCS activation. |
| EDS (all) | 8 | Post separation panel configuration (CSM/SLA separation) | Prelaunch | No further use after CSM/SLA separation. |
| SPS PITCH 1 BAT A | 8 | When SCS powered down after first SPS thrust | From launch through first SPS thrust and during subsequent SPS thrusts | Opened to prevent power drain through SCS TVC fail sensor. |
| SPS YAW 1 BAT A | 8 | When SCS powered down after first SPS thrust | From launch through first SPS thrust and during subsequent SPS thrusts | Opened to prevent power drain through SCS TVC fail sensor. |
| FC REACS (all) | 226 | Prelaunch after FC startup | Only when required to shut down fuel cell | Opened to ensure against inadvertent fuel cell shutdown. |
| FC RAD (all) | 226 | Prelaunch | Only when required to activate FC radiator bypass function | Bypass is only used in event of fuel cell failure. |
| MN REL (2) | 229 | Prelaunch | Only after splashdown | Opened to prevent premature main parachute release. |

GENERAL DATA

| Circuit Breakers | Panel Location | When Opened | When Closed | Remarks |
|---|---|---|---|---|
| O2 VAC ION PUMPS (2) | 229 | Prelaunch | When required | No requirements are defined for use of these circuit breakers at the present time. |
| PYRO A&B BAT BUS A&B (2) | 250 | Prelaunch | Only when required, if pyro bats indicate <35 vdc during bat check | Connects battery buses to pyro buses in event of pyro battery(s) failure. |
| BAT C TO BAT BUS A&B (2) | 250 | Prelaunch | When required to connect bat C to bat bus A or B | Connected when battery C is used to back up failed battery A or B. |
| MN A&B BAT C (2) | 275 | Prelaunch | Prior to deorbit and as required for bat A or B backup | Opened to isolate battery C from main buses. |
| FLT/PL BAT BUS A&B & BAT C (3) | 275 | Prelaunch | Prior to splashdown | Opened to isolate battery bus A & B and battery C from flight and post-landing bus. |
| UPR SYS COMPR (both) | 278 | Prelaunch | After splashdown | Opened to ensure against inadvertent activation of float bag compressors. |
| SIVB/LM SEP (2) | 278 | Following LM extraction | Prelaunch | No further use after LM is extracted from SIVB. |

### 4.5.1.3 Non-Dioded/Non-Switchable Loads

#### MAIN BUS A

EPS/CRYO
- Tk 1 H2 & 02 Htrs
- Inv 1 Pwr
- Util Outlets (pnl 15 & 16)
- Tk 1 02 Vac-Ion Pump

ECS
- C02 PP ind C/W lt & PCM
- Prim 2 Rad Htr Cont
- Rad Flow Contr 1 & Auto Sel
- Rad Isol vlv Man Sel
- H20 Accum 1 Auto & Man Cont
- Urine & Waste H20 Dump Htr A
- Steam Duct Htr A
- Sec Rad Htr Cont
- Sec Rad In & Out Temp ind & PCM

RCS
- CM Sys 1 Htrs
- CM Sys 1 Fuel & Oxid Purge
- CM Oxid Interconnect
- CM Fuel/He Interconnect
- CM Sys 1 Prplnt Dump 42 Sec TD
- CM Sys 1 Prplnt Isol vlv & tb
- SM B & D Htrs
- SM B & D He 1 & 2 Isol vlv & tb
- SM B & D Prim/Sec Prplnt Isol vlv & tb
- SM B & D Sec Fuel Press Isol vlv
- Trnfr Mot sw 1

SPS
- P & Y (Prim) Gmbl Mots
- Enbl Pwr Sol Driver 1
- He 1 vlv & tb
- Pilot 1 & 2 vlv
- Prim Pilot Pre vlv
- Line Htrs A
- PUGS Test

SCS
- FDAI 1 Total Att
- GDC (except RSI)
- BMAG 1 Htr & C/W Temp lt (eventually lose BMAG 1 as temp decr)
- Auto coils CM RCS 1 (if prior to CM/SM sep)
- Dir Ull Pitch C3 & A4
- Auto ΔV
- Auto Att Hold
- Rate 1 MTVC
- Rot Contr Pwr Dir 1
  - a. MNA/MNB to half of jets
  - b. MNA to all jets
- Rot Contr Pwr Dir 2, MNA/MNB to half of jets

LIGHTING
- RH Girth Shelf Flood (Fixed Mode)
- RH Couch Flood (Fixed Mode)
- LH Girth Shelf Flood (Var Mode)
- LH Couch Flood (Var Mode)
- LH & RH Strut Flood (Var Mode)
- LH Opt Align Sight
- Rndz lt
- Sys A Tunl lts (6 elements)

DISPLAYS & CONTROLS
- Msn Elapsed Tmr (pnl 2)

DOCKING
- Sys A Probe conn (however A & B conn may be switched)

## MAIN BUS B

EPS/CRYO
- Tk 2 H2 & 02 Htrs
- Inv 2 Pwr
- Util Outlet (pnl 100)
- LM Pwr
- Tk 2 02 Vac-Ion Pump

ECS
- 02 High Flow C/W lt
- Prim 1 Rad Htr Cont
- Rad Flow Contr 2
- Prim Rad In Temp ind & PCM
- H20 Accum 2 Auto & Man Cont
- Urine & Waste Dump Htr B
- Steam Duct Htr B

RCS
- CM Sys 2 Htrs
- CM Sys 2 Fuel & Oxid Purge
- CM Fuel Interconnect
- CM Oxid/He Interconnect
- CM Sys 2 Prplnt Dump 42 Sec TD
- CM Sys 2 Prplnt Isol vlv & tb
- SM A & C Htrs
- SM A & C He 1 & 2 Isol vlv & tb
- SM A & C Prim/Sec Prplnt Isol vlv & tb
- SM A & C Sec Fuel Press Isol vlv
- Trnfr Mot sw 2

SPS
- P & Y (Sec) Gmbl Mots
- Enbl Pwr Sol Driver 2
- He 2 vlv & tb
- Pilot 3 & 4 vlv
- Sec Pilot Pre vlv
- Line Htrs B

SCS
- FDAI 2 Total Att
- GDC
- BMAG 2 Htr & C/W Temp lt (eventually lose BMAG 2 as temp decr)
- Auto Coils CM RCS 2 (if prior to CM/SM sep)
- Dir Ull Yaw D3 & B4
- Auto $\Delta V$ (may be degraded)
- Min Imp Incr to ≈42 MS
- RSI
- ORDEAL
- Rot Contr Pwr Dir 1, MNA/MNB to half of jets
- Rot Contr Pwr Dir 2
  - a. MNA/MNB to half of jets
  - b. MNB to all jets

LIGHTING
- LH Girth Shelf Flood (Fixed Mode)
- LH Couch Flood (Fixed Mode)
- LH & RH Strut Flood (Fixed Mode)
- RH Couch Flood (Var Mode)
- RH Girth Shelf Flood (Var Mode)
- RH Opt Align Sight
- Sys B Tunl lts (6 elements)
- Spotlight Door Initiator

DISPLAYS & CONTROLS
- Msn Elapsed Tmr (pnl 306)

DOCKING
- Sys B Probe conn (however A & B conn may be switched)

| BAT BUS A | BAT BUS B | BAT RELAY BUS |
|---|---|---|
| EPS/CRYO<br>Mn Bus Tie A/C Mot sw | EPS/CRYO<br>Mn Bus Tie B/C Mot sw | EPS/CRYO<br>FC 1, 2, 3, Reacs vlvs, Latch Ckt & tbs<br>FC 1, 2, 3 Rad Byp vlvs & tbs<br>FC 1, 2, 3 to Mn Bus A & B Switching & tbs<br>Mn Bus A & B UV Sensing & UV C/W lt (if C/W NORM sw in ACK)<br>Inv 1, 2, 3 to AC Bus 1 & 2 & DC Bus Switching<br>AC Over/UV Sensing & C/W lt<br>AC Ovld C/W lt (if C/W NORM sw in ACK) |
| ECS<br>Prim Rad 1 Htr Ovld Snsr | ECS<br>Prim Rad 2 Htr Ovld Snsr<br>Sec Rad Htr Ovld Snsr | |
| RCS<br>SECS Auto RCS Trnfr to Trnfr Mot sw 1 | RCS<br>SECS Auto RCS Trnfr to Trnfr Mot sw 2 | |
| SPS<br>P & Y 1 (Prim) Gmbl Mot Cont | SPS<br>P & Y (Sec) Gmbl Mot Cont | |
| SCS<br>Auto RCS Sel MNA (if not previously enabled) | SCS<br>Auto RCS Sel MNB (if not previously enabled) | |
| SECS<br>SECS & ELS Sys A<br>Float Bag Compr 1<br>Float Bag 1 Mot sw & Cont vlv<br>EDS Voting Logic 1 | SECS<br>SECS & ELS Sys B<br>Float Bag Compr 2<br>Float Bag 2 Mot sw & Cont vlv<br>EDS Voting Logic 3 | |
| | BATTERY C | |
| | EDS Voting Logic 2 | |

## AC BUS 1

EPS/CRYO
- Tk 1 H2 & 02 Fans
- Tk 1 H2 & 02 Qty & Temp Sig Condr (ØC)

ECS
- Cab Fan 1
- Man Cont Prim Evap Stm vlv (ØC)
- Auto Cont Prim Gly Cont vlv (ØA)
- Sec Loop Evap Cool (ØA)
- Elect Cont Suit Ht Exch Gly Byp vlv (ØB)
- Rad Flow Contr 1 & Rad Isol vlvs (ØC)

SCS
- GDC (all modes except RSI)
- FDAI 1
- BMAG 1 (ATT HOLD, RATE CMD)
- Min Imp (ØA)
- RHC 1 MTVC (ØA)
- Rate Cmd Prplnt Att Cont (ØA)
- Auto ΔV (ØA)
- No. 1 Pitch & Yaw Needles on GPI (ØA)
- SII Fuel & SIVB Fuel & Oxid Press for ind No. 1 (ØA)

LIGHTING
- FDAI 1
- EMS Num & Grid
- Msn Tmr Num (pnl 2)
- DSKY Num (pnl 2)
- EL for pnls 1-9, 15, 16, 229, 275
- Sys 1 SM Run lts (6 elements) & EVA lt (1 element)

## AC BUS 2

EPS/CRYO
- Tk 2 H2 & 02 Fans
- Tk 2 H2 & 02 Qty & Temp Sig Condr (ØC)

ECS
- Cab Fan 2
- Prim Evap Temp Cont Unit (ØA)
- Auto Cab Temp Cont Unit (ØC)
- Rad Flow Contr 2 & Rad Isol vlvs (ØC)

SCS
- MTVC (RATE CMD, ACCEL CMD)
- Proportional RATE CMD (TVC, ATT CONT)
- FDAI 2
- BMAG 2
- RSI (ØA)
- GDC (ØA)
- Auto ΔV (TVC) (ØA)

ORDEAL
- No. 2 Pitch & Yaw Needles on GPI (ØA)
- SII Fuel & SIVB Fuel & Oxid Press for ind No. 2 (ØA)

LIGHTING
- EMS Roll Att & Scroll lts
- Msn Tmr Num (pnl 306)
- DSKY Num (pnl 140)
- EL for pnls 10, 100, 101, 122, 225, 226, 306
- Sys 2 SM Run lts (8 elements) & EVA lt (1 element)
- Dock Trgt & Spot lt

## PYRO BUS A

- Fuel/He Interconnect
- Ox Interconnect
- CM RCS 1 Purge vlvs
- Seq Sys A Func (pyros)

## PYRO BUS B

- Ox/He Interconnect
- Fuel Interconnect
- CM RCS 2 Purge vlv
- Seq Sys B Func (pyros)

### 4.5.1.4 Powerdown Electrical Loads

The following electrical loads list may be utilized to effect a powerdown if main buses should indicate less than 26 vdc with no short circuit verification. Three types of loads are provided to permit most rapid and effective selection for a given mission phase. A return to normal configuration should be established when main buses reach 26.5 vdc.

Use of list assumes that entry batteries A and B (battery C when applicable) have been tied to main buses before powerdown selections are made.

| | LAUNCH | FLIGHT | ENTRY | | |
|---|---|---|---|---|---|
| Load Control | Liftoff to Orbit Insertion | Orbit Insertion to Entry Preparation | Entry Preparation to 50K' | SPS Burns | Remarks |
| CONTINUOUS LOADS | | | | | |
| cb G/N (10) - open | | | 9.50 amp | | After 0.05 G |
| FC PUMPS (all) - OFF | 8.73 amp | 8.73 amp | 8.73 amp | 8.73 amp | Until CM/SM sep |
| IMU to stby | 6.33 amp | | | | |
| cb ESS INST (2) - open | 4.85 amp | 4.80 amp | 1.10 amp | 4.80 amp | MNA & B |
| S BD PWR AMPL HI - off (ctr) | 4.00 amp | 4.00 amp | 4.00 amp | 4.00 amp | |
| SUIT COMPR 1 (or 2) - OFF | | 4.00 amp/compr | 4.00 amp/compr | 4.00 amp/compr | Unsuited only |
| TELCOM (both) - OFF | 1.76 amp | 3.71 amp | 1.80 amp | 3.71 amp | Group 1 & 2 |
| cb G/N OPT (2) - open | | | 3.10 amp | | |
| GLY PUMPS - OFF | 2.57 amp | 2.57 amp | 2.57 amp | 2.57 amp | OFF no longer than 15 min |
| CMC to stby | 1.96 amp | | | | |
| G/N PWR - OFF | 1.50 amp | 1.50 amp | 1.50 amp | 1.50 amp | |
| cb RAD CONT/HTRS (2) - open | 1.05 amp | 1.05 amp | 1.05 amp | 1.05 amp | Until CM/SM sep |
| SCE PWR - off (ctr) | 0.65 amp | 0.65 amp | 0.65 amp | 0.65 amp | |

| Load Control | LAUNCH | FLIGHT | ENTRY | SPS Burns | Remarks |
|---|---|---|---|---|---|
| | Liftoff to Orbit Insertion | Orbit Insertion to Entry Preparation | Entry Preparation to 50K' | | |
| MANUALLY CYCLED LOADS | | | | | |
| GMBL MOT PITCH & YAW 2 - OFF | 10.0 amp | | | | At crew discretion |
| SPS LINE HTRS - off (ctr) | | 3.09 amp/bus | | 3.09 amp/bus | |
| SPS GAUGING - OFF | | | | 2.96 amp | |
| Min CM lighting | 1.57 amp | 1.57 amp | 1.57 amp | 1.57 amp | |
| TAPE RCDR FWD - off (ctr) | 1.57 amp | 1.57 amp | 1.57 amp | 1.57 amp | |
| AUTOMATICALLY CYCLED LOADS | | | | | |
| O2 HTRS (both) - off (ctr) | 11.05 amp | 11.05 amp | 11.05 amp | 11.05 amp | Until CM/SM sep |
| O2 FANS (both) - off (ctr) | | 5.40 amp | 5.40 amp | 5.40 amp | Until CM/SM sep |
| SM RCS HTRS (4) - OFF | | 2.09 amp/quad | 2.09 amp/quad | 2.09 amp/quad | Until CM/SM sep |
| POT H2O HTR - OFF | | 1.62 amp | | 1.62 amp | |
| H2 HTRS (both) - off (ctr) | 1.43 amp | 1.43 amp | 1.43 amp | 1.43 amp | Until CM/SM sep |
| H2 FANS (both) - off (ctr) | | 0.72 amp | 0.72 amp | 0.72 amp | Until CM/SM sep |

## 4.5.2 PROPULSION SYSTEMS

Specific functions of the SPS and RCS must be monitored to assure operational readiness and capability. SPS and SM RCS monitoring checks are performed during post-orbital insertion check and at 4-hour intervals and after each SPS burn. In addition, the SM RCS monitoring check is performed prior to each SPS burn. The CM RCS monitoring check is performed during post-orbital insertion check and at 12-hour intervals and prior to entry.

### 4.5.2.1 SPS Monitoring Check

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | SPS PRPLNT TEMP ind - +45° to +75°F | 3 | |
| | If <45°F, SPS LINE HTRS - A | | Use A/B position if double heater operation required for temperature control. |
| | If >75°F, SPS LINE HTRS - off (ctr) | | |
| | SPS PRESS IND sw - He, N2A, & N2B | | |
| | SPS He/N2 PRESS ind | | |
| | SPS He PRESS - 3900 psia max | | 3600±50 psia at launch, decreases with each burn. |
| | SPS N2 A PRESS - 2900 psia max | | 2900 psia at 130°F, decreases with each burn. |
| | SPS N2 B PRESS - 2900 psia max | | 2900 psia at 130°F, decreases with each burn. |
| | SPS PRESS IND sw - He | | |
| | SPS FUEL PRESS ind - 170-195 psia | | Fuel and oxidizer tanks pressurized with helium prior to launch. |
| | SPS OXID PRESS ind - 170-195 psia | | |
| | CAUTION<br>If ΔP between fuel & oxid is >20 psi prior to a critical SPS burn, repressurize prplnt tks manually by placing SPS He VLV (both) - ON. ΔP between tks >20 psi during a burn may result in degraded performance, rough combustion, &/or eng failure. Refer to SPS malfunction symptom, 5.2.2. | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| LMP | | SPS INJ VLV ind (4) - CLOSE | 3 | Each CLOSE indicates two propellant ball valves closed. |
| | | SPS OXID QTY ind - record<br>SPS FUEL QTY ind - record<br>SPS OXID UNBAL ind - record<br>OXID FLOW VLV PRIM - PRIM | | Quantity and unbalance indications may not be accurate subsequent to SPS burns of less than 25 seconds. |
| | | CAUTION<br>Do not sw to sec oxid flow vlv with prim vlv functioning properly. Failure of sec vlv could result in loss of prplnt management capability. If OXID FLOW VLV PRIM sw inadvertently set to SEC when no failure exists, return to PRIM before repositioning OXID FLOW VLV INCR sw. | | |
| | | SPS He VLV (both) - AUTO<br>SPS He VLV tb (both) - bp | | Barber pole indicates helium isolation valve closed. |
| | 4.5.2.2 | SM RCS Monitoring Check | | In addition to normal monitoring checks, all helium and propellant talkbacks (16) should be verified gray after any mechanical shock to CSM. |
| CMP | | SM RCS He tb (8) - gray | 2 | Gray indicates helium systems 1 & 2 isolation valves open. |
| | | SM RCS PRIM PRPLNT tb (4) - gray<br>SM RCS SEC PRPLNT tb (4) - gray<br>RCS IND sel - SM A, B, C, D | | Gray indicates primary and secondary fuel and oxidizer isolation valves open. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | Check Quads A, B, C, D<br>SM RCS PKG TEMP ind - 115°-175°F | 2 | Temperature maintained between 115° and 134°F by thermostatically controlled heaters. |
| | SM RCS He PRESS ind - record<br>SM RCS IND sw - He TK TEMP<br>SM RCS He TK TEMP ind - record<br>SM RCS IND sw - PRPLNT QTY<br>SM RCS PRPLNT QTY ind - record | | |
| | SM RCS SEC FUEL PRESS ind - 178-192 psia (192-207 psia until jets fired after orb insertion) | | Primary fuel pressure readout for each quad until momentary OPEN position of RCS A (B,C,D) SEC FUEL PRESS switch selected. |
| | When SM RCS SEC FUEL PRESS ind - <150 psia<br>SM RCS A (B,C,D) SEC FUEL PRESS - OPEN | | Decrease in fuel pressure indicates primary fuel low. OPEN position is momentary. |
| 4.5.2.3 | CM RCS Monitoring Check | | |
| | CM RCS PRPLNT tb (both) - gray | | Gray indicates propellant isolation valves open. |
| | RCS IND sel - CM 1, 2<br>CM RCS He TEMP ind - 60°-90°F<br>Prior to CM RCS activation<br>CM RCS He PRESS ind - 4100-4200 psia<br>CM RCS MANF PRESS ind - 80-105 psia | | GSE servicing pressure monitored until system activated. Pressure varies with temperature and ullage. If manifold pressure drops suddenly, indicating a ruptured burst diaphragm, close CM RCS propellant isolation valves and then preheat jets (4.15.1.4) for 15 minutes. Preheating procedure vents any propellant trapped between propellant isolation valves and jets by energizing jet valve direct coils. |
| | After CM RCS activation<br>CM RCS He PRESS ind - stab at 3300-3500 psia ≈15 min after activation<br>CM RCS MANF PRESS ind - 287-302 psia | | |

## 4.5.3 ELECTRICAL POWER SYSTEM

### EPS Management

The normal EPS configuration will be with two fuel cells on main bus A and one on main bus B, e.g., FC 1 and 2 on MNA and FC 3 on MNB. If one fuel cell is to be removed from buses, one of two configurations may be assumed. The prime configuration is one fuel cell per bus; for example, fuel cell 1 to main bus A and fuel cell 3 to main bus B. This configuration requires a dual inverter configuration and subsequent load balancing after fuel cell configuration has been established. The second configuration is to have two fuel cells paralleled to buses. This configuration should not be assumed unless equipment malfunction does not permit load balancing or one of the remaining fuel cells performance is degraded.

Standby operation (in-line heaters, reactants and pumps remain on) may be used when powering down spacecraft, as a corrective action for fuel cell malfunctions, or in the event it is desired to hold a fuel cell in reserve for future use. Batteries and remaining fuel cells should be normal when a fuel cell is placed on standby operation (open circuit). Inline heaters and pumps should not be turned off unless fuel cell is to be shut down. If, during the mission, it becomes necessary to conserve cryogenics, electrical loads should be reduced which will in turn decrease flow of cryogenics to fuel cells. In an emergency situation, consideration may be given to deactivate a fuel cell (inline heaters, pumps, and loads off) to conserve cryogenics. During deactive period, continuous monitoring of the fuel cell system will not necessarily assure a reactivation capability and there exists a possibility of complete loss of the fuel cell.

The prime inverter configuration is to have inverter 1 powering ac bus 1 and inverter 2 powering ac bus 2, with inverter 3 as backup. This configuration permits optimum bus isolation; however, reliability of the inverter permits single inverter operation to both ac buses if cryogenics are to be conserved.

Entry batteries A and B will normally supply main bus A and main bus B respectively with battery C as backup. The batteries (2) should be on during countdown, lift-off, and all delta V maneuvers. Battery C will supply the buses prior to deorbit burn and as required throughout the mission.

Battery C will be connected to buses as required to provide two-battery configuration for delta V maneuvers. All three batteries are to be used during final deorbit burn.

The battery charging cycle should be terminated when either the battery bus voltage indicated on PCM exceeds 39.5 vdc or when 100 percent of the expended energy has been replaced. This presumes charger current PCM data availability, and integration of charge current on the ground with MSFN advice to crew when 100 percent of charge is returned. If PCM link is lost, voice readouts of the onboard charger DC AMPS indicator will be required at intervals of 20 to 30 minutes for integration on the ground. Charging may be resumed if interrupted before achieving terminal conditions previously listed. Normal practice is to continue any charge to completion.

Batteries will be checked prior to each GO/NO-GO flight decision, prior to deorbit burn, and in routine periodic checks as required.

The onboard readout will be prime readout throughout EPS checks.

Fuel cell periodic verification consists of updating onboard data and comparing respective fuel cell performance for a particular phase, with established history of the powerplant.

Normal fuel cell purge requirements will be established in flight on the basis of prelaunch purity tests and elapsed amp-hours since previous purge. Purging will also be required just prior to GO/NO-GO flight decisions. Purging is accomplished by sequentially purging $O_2$ (for 120 seconds) then $H_2$ (for 80 seconds).

The time required for the $H_2$ vent line heater activation prior to $H_2$ purge has been set at 20 minutes. This time is flexible in that a purge may be attempted with less heater time (for example, a contingency corrective action) with no immediate adverse effect on the powerplant.

### Cryogenic System Operational Regions

There are four basic cryogenic system operational regions based on control requirements. Quantity balance should be obtained by end of Region I to assure optimum fluid quantity remaining in Regions III and IV. These regions and their respective quantity balance requirements are:

#### Region I - Automatic Control Region

Quantity balance correction is to be implemented at a 3-percent differential for hydrogen and for oxygen a differential from 2 percent to 4 percent. Unbalanced conditons of 5 percent for $O_2$ and 4 percent for $H_2$ should be avoided.

Region II - Minimum dq/dm Region

Quantity balancing procedures should not be implemented in this region.

Region III - Post Minimum dq/dm Region

Quantity balancing correction should be implemented on the same basis as in Region I. Heater switches may be in either manual or AUTO and fan switches should be operated manually, depending on balancing requirements.

Region IV - Terminal Region

Quantity balancing procedures should not be implemented.

#### 4.5.3.1 Cryogenic Pressure-Quantity Check

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | CRYO H2 PRESS ind (both) - 225-260 psia | 2 | Indicates H2 tank 1 and 2 pressure. |
| | 02 PRESS IND sw - SURGE TK<br>CRYO 02 PRESS 1 ind - 865-935 psia | | Indicates surge tank 02 pressure. |
| | 02 PRESS IND sw - TK 1<br>CRYO 02 PRESS ind (both) - 865-935 psia | | Indicates 02 tank 1 and 2 pressure. |
| | CRYO H2 QTY ind (both) - record | | Nominal per mission profile curve, 100 percent maximum indicates full tank (28 pounds each tank). |
| | CRYO 02 QTY ind (both) - record | | Nominal per mission profile curve, 100 percent maximum indicates full tank (320 pounds each tank). |
| | SYS TEST (2) - 4B<br>SYS TEST ind - 4.1-4.4 vdc | 101 | Indicates 02 tank 3 pressure (865-935 psia). |
| | SYS TEST (2) - 4D<br>SYS TEST ind - 3.2-3.8 vdc | | Indicates H2 tank 3 pressure (225-265 psia). |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | SYS TEST (2) - 4A | 101 | |
| | SYS TEST ind - record | | Indicates O2 tank 3 quantity. |
| | SYS TEST (2) - 4C | | |
| | SYS TEST ind - record | | Indicates H2 tank 3 quantity. |
| 4.5.3.2 | FC Power Plant Check | | |
| LMP | FC HTRS (all) - on (up) | 3 | Enables electronic switches which automatically apply or remove power to fuel cell heaters. |
| | FC REACS tb (all) - gray | | Gray indicates fuel cell reactant valves open. |
| | FC IND sel - 1, 2, 3 | | |
| | FC H2 FLOW ind - 0.03-0.15 lb/hr<br>FC O2 FLOW ind - 0.25-1.2 lb/hr<br>FC SKIN TEMP ind - 390°-450°F | | Flow limits are proportional to individual fuel cell currents and can be approximated by fuel cell O2 flow ≈(amps x 2.0)/100, and fuel cell H2 flow ≈(amps x 2.5)/1000. |
| | FC COND EXH TEMP ind - 150°-175°F | | |
| | FC pH HI tb - gray | | Gray indicates pH factor normal. |
| | FC RAD TEMP LO tb - gray | | Gray indicates fuel cell radiator temperatures normal. |
| 4.5.3.3 | D-C Voltage-Amperage Check | | |
| | MN BUS TIE (2) - OFF (verify) | 5 | |
| | FC 1 & 2 MNA tb (2) - gray<br>FC 3 MNA tb - bp | 3 | Gray indicates fuel cells 1 and 2 connected to main bus A. Barber pole indicates fuel cell 3 disconnected from main bus A. |
| | FC 1 & 2 MNB tb - bp<br>FC 3 MNB tb (2) - gray | | Barber pole indicates fuel cells 1 and 2 disconnected from main bus B. Gray indicates fuel cell 3 connected to main bus B. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | DC IND sel - FC 1, 2, 3 | 3 | |
| | DC AMPS ind - record amps | | Record dc amps for each fuel cell. |
| | DC IND sel - MNA, B | | |
| | DC VOLTS ind - 26.5-31 vdc (record) | | Record dc volts for main buses A and B. |
| | DC IND sel - BAT BUS A, B, & BAT C | | |
| | DC VOLTS ind - 31.5-38.0 vdc | | Voltage indication may be different than shown when charging battery. |
| | DC AMPS ind - <3.0 amps | | |
| CMP | SYS TEST (2) - 5B | 101 | Verifies battery relay bus voltage 30.5 to 37.0 vdc and verifies system test indicator. Perform if convenient. |
| | SYS TEST ind - 3.4-4.1 vdc | | |
| | If LM PWR - CSM | 2 | |
| | SYS TEST (2) - 7D | 101 | |
| | SYS TEST ind - 0.5-3.2 vdc | | Verifies LM heater current is 1 to 6.4 amps. |
| | CAUTION<br>Do not leave DC IND sel at PYRO BAT A (B) position any longer than req to read DC VOLTS ind, or pyro bat chg will be depleted. | | |
| LMP | DC IND sel - PYRO BAT A, B | 3 | Check pyro batteries A and B once every 24 hours. |
| | DC VOLTS ind - 36.5-37.5 vdc | | |
| | DC IND sel - MNA | | |
| | 4.5.3.4 A-C Voltage Check | | |
| | AC IND sel - BUS 1, 2, ϕA, B, C | | |
| | AC VOLTS ind - 113-117 vac | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.5.3.5 Battery Charging | | |
| LMP | MN BUS TIE (2) - OFF | 5 | Placing MN BUS TIE switches at OFF completes circuit from charger to selected battery and disconnects battery from main bus. |
| | cb PYRO A & B BAT BUS A & B (2) - open | 250 | |
| | cb BAT C TO BAT BUS A & B - open | | |
| | cb BAT RLY BUS BAT A (B) - open | 5 | |
| | DC IND sel - BAT CHGR | 3 | |
| | BAT CHG - A, B, or C | | |
| | CAUTION<br>If bat chg is started immediately after discharge, chgr current may be high &/or chgr voltage may be low. Current & voltage should be within specified limits 45 min after initiation of chg, otherwise trnfr chgr to remaining bats. After remaining bats are charged, return chgr to affected bat. | | |
| | DC VOLTS ind - 37.5-39.5 vdc | | |
| | BAT CHG - OFF (at MSFN request or when DC VOLTS ind reads 39.5 vdc for bat bus A, B or bat C) | | |
| | cb BAT RLY BUS BAT A (B) - close | 5 | |
| | DC IND sel - MNA | 3 | |
| CMP | SYS TEST (2) - 7A | 101 | |
| | SYS TEST ind - <1.5 vdc | | |
| | (After sea level amb press ≈14 psia has been vented) | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | If >1.5 vdc<br>BAT VENT vlv - VENT (for 5 sec) then CLOSE | 252 | Battery vent manifold pressure >6 psia (1.5 vdc) indicates a gross battery malfunction which should have become apparent prior to manifold pressure increase. If manifold pressure ≈ cabin pressure, leakage into battery case(s) is indicated which will have no effect on battery performance. Battery vent valve should not be opened if waste water tank is full or is being manually dumped overboard, or if OVBD DRAIN valve is open with urine dump line interconnected to waste water dump line. |
| | | SYS TEST (2) - 5B | 101 | Monitors battery relay bus voltage. |
| | 4.5.3.6 | FC Power Plant Purging | | |
| LMP | 1 | O2 purging<br>FC IND sel - 1, 2, or 3<br>FC 1, 2, or 3 PURG - O2 (2 min) | 3 | Refer to purge information at beginning of 4.5.3. Purging is performed as determined by real time decision. |
| | | FC O2 FLOW ind - flow incr 0.6 lb/hr | | O2 flow rate will increase by 0.6 lb/hr. This may cause FC O2 FLOW indicator to exceed its normal limits and activate MASTER ALARM pb/lt (3) and FC 1 (2 or 3) light. Alarm limits may be checked by monitoring FC O2 FLOW indicator at the moment C/W light comes on.<br>● If normal O2 flow is at lowest limits, purging O2 side of fuel cell will not cause MASTER ALARM pb/lt to come on. |
| | | FC 1, 2, or 3 PURG - OFF | | |
| | 2 | H2 purging<br>H2 PURG LINE HTR - on (up), 20 min prior to purge | | Refer to purge information at beginning of 4.5.3. Purging is performed as determined by real time decision. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | FC IND sel - 1, 2, or 3<br>FC 1, 2, or 3 PURG - H2<br>(1 min, 20 sec)<br>FC H2 FLOW ind - flow incr<br>0.67 lb/hr | 3 | H2 flow rate will increase by 0.67 lb/hr. This will cause FC H2 FLOW indicator to exceed its normal limits, and activate MASTER ALARM pb/lt (3) and FC 1 (2 or 3) light. |
| ALL | MASTER ALARM pb/lt (3) - on<br>MASTER ALARM pb/lt - push<br>MASTER ALARM pb/lt (3) - out | 1,3,122 | |
| CMP | FC 1, 2, or 3 lt - on (until norm flow restored) | 2 | |
| LMP | FC 1, 2, or 3 PURG - OFF<br>After ≈10 min<br>H2 PURG LINE HTR - OFF | 3 | |
| | 4.5.3.7 H2 or 02 Quantity Balance Correction | | Refer to quantity balance information at beginning of 4.5.3. |
| | On low qty tk | | |
| CMP | H2 or 02 HTRS 1 (2) - off (ctr) | 2 | |
| | When tk qty balanced<br>H2 or 02 HTRS 1 (2) - AUTO | | |
| | 4.5.3.8 FC Load Disconnect<br>(Example using FC 2) | | This procedure is presented with the following assumptions:<br>Fuel cells 1 and 2 powering dc main bus A.<br>Fuel cell 3 powering dc main bus B. |
| | a. Prior to Disconnect | | |
| LMP | Ensure that at least one FC is powering each mn bus | | |
| | FC disconnect<br>(1) Prime configuration | | Requires load balancing. |
| | FC 2 MNA - OFF<br>FC 2 MNB - OFF (verify) | 3 | Fuel cell 2 is now disconnected from both dc main buses. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | FC 2 MNA & B tb (2) - bp | 3 | Barber poles indicate fuel cell 2 is disconnected from main bus A and main bus B. |
| | FC 1 MNA tb - gray | | Gray indicates fuel cell 1 is connected to main bus A. |
| | FC 1 MNB tb - bp | | Barber pole indicates fuel cell 1 is disconnected from main bus B. |
| | FC 3 MNA tb - bp | | Barber pole indicates fuel cell 3 is disconnected from main bus A. |
| | FC 3 MNB tb - gray | | Gray indicates fuel cell 3 is connected to main bus B. |
| | (2) Sec configuration | | This configuration is assumed if load balancing cannot be obtained. |
| | FC 1 MNB - on (up)<br>FC 3 MNA - on (up) | | On position is momentary. When fuel cell main bus switches are placed from OFF to momentary on position, MASTER ALARM and FC BUS DISC lights are energized. |
| | FC 2 MNA - OFF<br>FC 2 MNB - OFF (verify) | | Fuel cell 2 disconnected from both dc main buses. Fuel cells 1 and 3 paralleled to both dc main buses. |
| ALL | MASTER ALARM pb/lt (3) - on | 1,3,122 | |
| CMP | FC BUS DISC lt - on (mom) | 2 | |
| ALL | MASTER ALARM pb/lt - push, out | 1,3,122 | |
| CMP | C/W lts (all) - out | 2 | |
| LMP | FC 1 MNA & B tb (2) - gray | 3 | Gray indicates fuel cell 1 connected to main bus A and B. |
| | FC 3 MNA & B tb (2) - gray | | Gray indicates fuel cell 3 connected to main bus A and B. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | FC 2 MNA & B tb (2) - bp | 3 | Barber poles indicate fuel cell 2 disconnected from main bus A and B. |
| | b. Conn Desired FC to Desired Mn Bus<br>FC to bus conn | | |
| | FC 2 MNA - on (up) | | On position is momentary. When fuel cell main bus switches placed from OFF to momentary on position, MASTER ALARM and FC BUS DISC lights are energized. |
| | FC 1 MNB - OFF<br>FC 3 MNA - OFF | | Fuel cells returned to normal configuration (fuel cell 1 and 2 powering dc main bus A and fuel cell 3 powering dc main bus B). |
| ALL | MASTER ALARM pb/lt (3) - on | 1,3,122 | |
| CMP | FC BUS DISC lt - on (mom) | 2 | |
| ALL | MASTER ALARM pb/lt - push, out | 1,3,122 | |
| CMP | C/W lts (all) - out | 2 | |
| LMP | FC 2 MNA tb - gray<br>FC 2 MNB tb - bp | 3 | Gray indicates fuel cell 2 connected to main bus A, barber pole indicates fuel cell 2 disconnected from main bus B. |
| | FC 1 MNA tb - gray | | Gray indicates fuel cell 1 connected to main bus A. |
| | FC 1 MNB tb - bp | | Barber pole indicates fuel cell 1 disconnected from main bus B. |
| | FC 3 MNA tb - bp | | Barber pole indicates fuel cell 3 disconnected from main bus A. |
| | FC 3 MNB tb - gray | | Gray indicates fuel cell 3 connected to main bus B. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.5.3.9 | Inverter Changeover | | Normal operation throughout mission will be with 2 inverters operating. During drifting flight, a single inverter is adequate to power both ac buses; however, two-inverter operation is assumed, providing maximum bus isolation. |
| | | WARNING<br>Ensure at least one inv on each ac bus at all times (if available). | | If 3 inverters are switched onto one ac bus, loss of ac power to that bus will result. |
| | a. | Dual Inv (No. 1 & 2) Oper | | This procedure is presented with the assumption that inverter 1 is powering ac bus 1 and 2. |
| LMP | | AC2 RSET - OFF | 3 | |
| | | INV 2 - MNB | | During dual inverter operation, inverter connected to dc main bus A should always power ac bus 1 and inverter connected to dc main bus B should always power ac bus 2, to preclude loss of all ac and dc power to SCS in event of single dc main bus failure. |
| | | INV 1 AC2 - OFF | | S-band phaselock will be lost upon switching inverters. |
| | | INV 2 AC2 - on (up) | | Inverter 1 now powering ac bus 1 and inverter 2 powering ac bus 2. Rapid performance of inverter switching sequence may initiate MASTER ALARM pb/lt when inverter is connected to bus. |
| | | AC2 RSET - RSET | | RSET position is momentary. |
| ALL | | MASTER ALARM pb/lt (3) - on<br>MASTER ALARM pb/lt - push<br>MASTER ALARM pb/lt (3) - out | 1,3,122 | Placing AC1 or 2 RSET switch to RSET and releasing ensures a MASTER ALARM pb/lt - on. Placing AC1 or 2 RSET to center will cause random activation of MASTER ALARM pb/lt. |
| CMP | | C/W lts (all) - out | 2 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| LMP | | Perform AC Voltage Check, 4.5.3.4 | | |
| | b. | Single Inv Oper | | This procedure is presented with the assumption that inverter 1 is powering ac bus 1 and inverter 2 is powering ac bus 2. |
| | | AC2 RSET - OFF | 3 | |
| | | INV 2 - OFF | | |
| | | INV 2 AC2 - OFF | | S-band phaselock will be lost upon switching inverters. |
| | | INV 1 AC2 - on (up) | | Inverter 1 now powering ac bus 1 and ac bus 2. Rapid performance of inverter switching sequence may initiate MASTER ALARM pb/lt when inverter is connected to bus. |
| | | AC2 RSET - RSET | | RSET position is momentary. |
| ALL | | MASTER ALARM pb/lt (3) - on | 1,3,122 | Placing AC1 or 2 RSET switch to RSET and releasing ensures a MASTER ALARM pb/lt - on. Placing AC1 or 2 RSET to center will cause random activation of MASTER ALARM pb/lt. |
| | | MASTER ALARM pb/lt - push | | |
| | | MASTER ALARM pb/lt (3) - out | | |
| CMP | | C/W lts (all) - out | 2 | |
| LMP | | Perform AC Voltage Check, 4.5.3.4 | | |
| | c. | Stby Inv (No. 3) Check or Oper | | This procedure is presented with the assumption that inverter 1 is powering ac bus 1 and inverter 2 is powering ac bus 2. |
| | | AC2 RSET - OFF | 3 | |
| | | INV 2 - OFF | | |
| | | INV 3 - MNB | | When switching inverter 3 from one main dc bus to the other, pause momentarily in OFF position. |
| | | INV 2 AC2 - OFF | | S-band phaselock will be lost upon switching inverters. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | INV 3 AC2 - on (up) | 3 | Rapid performance of inverter switching sequence may initiate MASTER ALARM pb/lt when inverter is connected to bus. |
| | AC2 RSET - RSET | | RSET position is momentary. |
| ALL | MASTER ALARM pb/lt (3) - on<br>MASTER ALARM pb/lt - push<br>MASTER ALARM pb/lt (3) - out | 1,3,122 | Placing AC1 or 2 RSET switch to RSET and releasing ensures a MASTER ALARM pb/lt - on. Placing AC1 or 2 RSET to center will cause random activation of MASTER ALARM pb/lt. |
| CMP | C/W lts (all) - out | 2 | |
| LMP | Perform AC Voltage Check, 4.5.3.4 | 3 | Standby inverter (No. 3) check should be performed every 24 hours. |
| | If stby inv check<br>Go to dual inv (No. 1 & 2) oper, 4.5.3.9a, & set INV 3 - OFF | | |
| 4.5.3.10 | Cryo O2 & H2 Manual Fan Operation | | Manual fan operation should be used during flight to prevent possible cryo pressure control motor switch arcing, which may cause a-c inverter a-c bus disconnect. |
| | CAUTION<br>In the following step, if CRYO PRESS lt illuminates, do not set H2 & O2 FANS - off (ctr) or proceed to next step until lt extinguishes. | | |
| | Procedures to be determined. | | |

## 4.5.4 ENVIRONMENTAL CONTROL SYSTEM

ECS systems management procedures are divided into two categories. The first category consists of five procedures, described in steps 1 through 5, that are conducted at specific time intervals.

1. An ECS monitoring check is recommended every hour from time the SC attains orbit until CSM separation. This check provides crew with latest status of the ECS.

2. A redundant component check is accomplished at 24-hour intervals to determine operational status of certain ECS redundant components and secondary water-glycol loop. The test will reveal any inoperative or malfunctioning components that might have been selected for use later in the mission. Several redundant components are not checked, however, because of excessive use of oxygen, a means of selection not incorporated, or lack of direct indication.

3. Replacement of one CO2-odor absorber filter is required on an alternate basis, at 12-hour intervals, for the ECS to remain within prescribed metabolic limit. Filters are also changed if CO2 partial pressure exceeds 7.6 mm Hg.

4. It is recommended that at 24-hour intervals the debris screen on suit circuit return valve be checked and cleaned as necessary.

5. It is recommended that chlorine and a buffer chemical be individually injected into potable water supply every 24 hours to maintain potability. There is a 10-ampoule supply of each chemical on the CM. Should a condition exist where either glycol evaporator is in use and waste water tank is empty, chlorine and buffer injections should be postponed.

The second category consists of procedures, described in steps 1 through 15, that are accomplished at random intervals or only as required.

1. PGA/shirtsleeve mode changes require certain precautions to be taken regarding suit power switch settings, communication functions and ECS adjustments. This applies whether the mode change is from PGA-to-shirtsleeve, shirtsleeve-to-PGA, or full PGA to partially suited mode. Also specified is a configuration for extravehicular and intravehicular transfer (EVT/IVT).

2. Waste management procedures provide the steps necessary for collection, removal, and disposition of waste products (except perspiration and respiration) resulting from normal body functions. Collection and disposition of emesis within the CM is also covered.

3. Procedures are provided to repressurize the CM cabin to 5 psia following depressurization for any reason.

4. A verification of the PGA is carried out each time a crewman dons his suit. Although only one crewman may be returning to the suited mode, all those already suited will be subjected to PGA verification. The verification is also performed prior to S-IVB separation, SPS burns, cabin pressure dumping, EVT, IVT, and deorbit.

5. The CM oxygen supply, represented by the surge tank and repressurization tanks (3), requires replenishment after cabin repressurization.

6. The CM pressure dump procedure is utilized for extravehicular transfer (EVT).

7. The suit circuit, when isolated from the cabin, will be purged of accumulated hydrogen at the discretion of flight crew.

8. The cabin cold-soak operation is recommended for any period for which a cooler cabin is desirable, provided water consumption is compatible with water management, and radiator outlet temperature is greater than 0°F. The procedure may commence 8 to 12 hours prior to entry if a safety margin for entry is deemed advisable. Primary and secondary radiator loops are not to be operated simultaneously.

9. The CM/LM pressure equalization procedure will normally be performed to support initial hard docking and LM withdrawal, and intravehicular crew transfer from either CM or LM.

10. A procedure is provided for donning and doffing of emergency oxygen masks.

11. A procedure is provided to manually dump waste water overboard. This procedure is required approximately once per day to maintain waste water tank quantity level between 85 and 25 percent.

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|

12. Data for servicing the gas separator cartridges is provided. The separators are used as a backup for separating H2 from H20 in the normal system.

13. The steps required to activate or deactivate the primary glycol evaporator are provided, if such action becomes necessary for lunar orbital path perturbations due to steam venting or for any other reason.

14. Prior to CM/LM rendezvous, the command module pilot should install the lunar dust filter over the cabin fan outlet. The filter should remain in place for 4 hours of cabin fan operation, starting when the CM and LM hatches are removed. This will ensure adequate lunar dust removal from the CM.

15. A procedure is provided for the use of the lunar dust vacuum cleaner following CM/LM rendezvous. Although this component is stowed in and is powered from the CM, its use within the LM is permitted by the length of the power cable.

### 4.5.4.1 ECS Monitoring Check

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | SUIT CAB ΔP ind - -1.0 to -3.5 in. H20 | 2 | |
| | 02 FLOW ind - 0.2-0.45 lb/hr | | 02 flow may be as high as 1.0 lb/hr (pegged) prior to completion of cabin purge. |
| | 02 PRESS IND sw - SURGE TK | | |
| | CRYO 02 PRESS 1 ind - 865-935 psia | | |
| | 02 PRESS IND sw - TK 1 | | |
| CMP | REPRESS 02 PRESS ind - >865 psia | 602 | |
| LMP | ECS RAD tb - gray | 2 | Gray indicates No. 1 flow proportioning valve controlling flow. |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>x x | | |
| | If ECS RAD tb - 2<br>RAD FLOW CONT AUTO - 1 until tb gray, then AUTO | | Attempt resetting talkback before assuming radiator proportioning malfunction. |

ENVIRONMENTAL CONTROL SYSTEM

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | If tb cannot be reset<br>RAD FLOW CONT AUTO - 1<br>RAD PRIM OUT TEMP ind - within correct rng | 2 | Correct range indicates talkback malfunction only, with both proportioning systems and failure detection circuit operable. |
| | RAD FLOW CONT AUTO - AUTO<br>RAD PRIM OUT TEMP ind - outside correct rng<br>Refer to ECS Malfunction Proced, PRIM ECS RAD OUT TEMP HIGH, Symptom 15 | | |
| | x x<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | ECS IND sel - PRIM<br>RAD PRIM IN TEMP ind - 67°-97°F<br>RAD PRIM OUT TEMP ind - -20° to 63°F (-20° to 97°F for lunar orb)<br>PRIM GLY EVAP OUT TEMP ind - 38°-50.5°F<br>PRIM GLY EVAP STM PRESS ind<br>When boiling - 0.09-0.14 psia<br>Not boiling - >0.14 psia<br>PRIM GLY DISCH PRESS ind - 40-52 psig<br>SUIT TEMP ind<br>Without evap - 45°-70°F<br>With evap - 45°-55°F<br>CAB TEMP ind - 70°-80°F | | |
| | SUIT PRESS ind - ≈CAB PRESS ind<br>CAB PRESS ind - 4.7-5.3 psia | | Cabin pressure will be 5.6 to 6.2 psia after launch and continuously decrease until cabin pressure regulator activates and controls to 4.7 to 5.3 psia. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| LMP | | CO2 PP ind - <7.6 mm Hg | 2 | |
| | | SUIT COMPR ΔP ind - 0.3-0.4 psid | | |
| | | PRIM ACCUM QTY ind - 30-65% | | |
| | | If qty <30% | | |
| CMP,LMP | | PRIM ACCUM FILL vlv - ON until 40-55% is reached | 379,2 | |
| LMP | | H2O QTY IND sw - POT | 2 | |
| | | POT H2O QTY ind - 10-100% | | |
| | | H2O QTY IND sw - WASTE | | |
| | | WASTE H2O QTY ind - 25-85% | | |
| | | If >85% - dump per 4.5.4.16 | | |
| | 4.5.4.2 | ECS Redundant Component Check | | |
| | 1 | Suit compr | | |
| | | SUIT COMPR (both) - redundant compr | 4 | |
| | | SUIT COMPR ΔP ind - 0.3-0.4 psid | 2 | |
| | 2 | Suit demand regs | | |
| CDR | | DEMAND REG sel - 1 | 380 | |
| | | Close demand reg cab bleed port with finger | | Obstruct bleed flow only long enough to obtain momentary high flow. |
| LMP | | O2 FLOW ind - mom incr | 2 | |
| CDR | | DEMAND REG sel - 2 | 380 | |
| | | Close demand reg cab bleed port with finger | | Obstruct bleed flow only long enough to obtain momentary high flow. |
| LMP | | O2 FLOW ind - mom incr | 2 | |
| CDR | | DEMAND REG sel - BOTH | 380 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 3 | Main 02 regs | | |
| CMP | | MN REG B - close | 351 | |
| | | EMER CAB PRESS sel - 1 | | |
| | | EMER CAB PRESS TEST pb - push | | Press-to-test pushbutton held only long enough to obtain momentary high flow. |
| LMP | | 02 FLOW ind - pegged hi | 2 | |
| CMP | | MN REG B - OPEN | 351 | |
| | | MN REG A - close | | |
| | | EMER CAB PRESS sel - 2 | | |
| | | EMER CAB PRESS TEST pb - push | | Press-to-test pushbutton held only long enough to obtain momentary high flow. |
| LMP | | 02 FLOW ind - pegged hi | 2 | |
| CMP | | MN REG A - OPEN | 351 | |
| | | EMER CAB PRESS sel - BOTH (OFF if all crewmen suited) | | |
| | 4 | H20 accum | | |
| LMP | | SUIT H20 ACCUM AUTO - redundant accum | 2 | |
| | | 02 FLOW ind - mon for momentary (10 sec) incr | | Allow up to 10 minutes for accumulator stroking. |
| | 5 | Urine dump nozzle htrs | | |
| CMP | | WASTE H20 DUMP - redundant htr | 101 | |
| | | URINE DUMP - redundant htr | | |
| | | MSFN reports no significant change in urine & water dump nozzle temps | | Nozzle temperatures are telemetered only. Temperature decrease indicates heater failure; however, if nozzles are facing sun, decrease may not be immediate. |
| | 6 | Open cool cont atten pnl | | Covers panel 382. Opened to perform part of secondary glycol loop check. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | WARNING | | |
| CMP | | SUIT FLOW RELF vlv must remain OFF throughout msn or swelling of CO2 odor absorber filters may result. | 382 | |
| | 7 | Sec gly loop | | Coldplates are not provided in secondary glycol loop for DSE and G&N. Usage time for noncoldplated items is as follows:<br>DSE: 2 hours ON, 1 hour OFF.<br>G&N: 1.9 hours ON, 9.2 hours OFF. |
| | | CAUTION | | |
| | | Simultaneous oper of cryo O2 htrs & sec loop rad htrs will result in low mn bus voltage ($<26.5$ vdc). This will be precluded if the following precautions are observed. | | |
| LMP | | If RAD PRIM OUT TEMP ind - $\leq 48$°F preceding sec loop activation, or if RAD SEC OUT TEMP ind - $\leq 45$°F following sec loop activation: | 2 | |
| | | • Inhibit cryo O2 htrs whenever cryo tk press $<900$ psia [O2 HTRS (both) - off (ctr)]. Enbl cryo htrs when RAD SEC OUT TEMP ind - $>48$°F. | | |
| | | • Enbl sec loop rad htrs when mn bus A & B $\geq 28.25$ vdc with 3 FC oper or $\geq 28.5$ vdc with 2 FC oper. | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | SEC EVAP H20 CONT - AUTO | 382 | |
| LMP | | ECS IND sel - SEC | 2 | |
| | | GLY EVAP STM AUTO - MAN | | |
| | | GLY EVAP STM INCR - INCR for 58 sec min | | Steam pressure valve requires 58 seconds from full open to full closed. INCR position is momentary. |
| CMP | | GLY TO RAD SEC vlv - NORM | 377 | |
| LMP | | RAD PRIM HTR - off (ctr) | 2 | |
| | | GLY PUMPS - OFF | 4 | |
| | | SEC COOL PUMP - AC1 | 2 | |
| | | SEC GLY DISCH PRESS ind - 39-51 psig | | |
| | | SEC ACCUM QTY ind - 30-55% | | |
| | | RAD SEC HTR - on (up) | | |
| | | SEC COOL EVAP - EVAP | | |
| | | SEC GLY EVAP STM PRESS ind | | |
| | | When boiling - 0.09-0.14 psia | | |
| | | Not boiling - >0.14 psia | | |
| | | After 20-30 min | | Allow 20 to 30 minutes of glycol circulation before reading temperature indicators. |
| | | RAD SEC IN TEMP ind - 60°-97°F | | |
| | | RAD SEC OUT TEMP ind - 40°-70°F (pegged) | | 75°F (actual) with high loads and worst case orientation, or >75°F (actual) during the subsolar point of lunar orbit. |
| | | SEC GLY EVAP OUT TEMP ind - 40°-50.5°F | | |
| | | SEC COOL PUMP - AC2 | | |
| | | SEC GLY DISCH PRESS ind - 39-51 psig | | |
| | | SEC COOL EVAP - RSET for 58 sec min, then off (ctr) | | RSET closes steam pressure control valve. Steam pressure valve requires 58 seconds from full open to full close. |
| | | RAD SEC HTR - OFF | | |
| CMP | | GLY TO RAD SEC vlv - BYP | 377 | |
| LMP | | ECS IND sel - PRIM | 2 | |
| | | SEC COOL PUMP - off (ctr) | | |
| CMP | | SEC EVAP H20 CONT - OFF | 382 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 8 | Close cool cont atten pnl | 382 | Covers panel 382. |
| | 9 | Prim gly pumps | | |
| LMP | | GLY PUMPS - redundant pump | 4 | Switch to pump opposite that on at beginning of test. This verifies primary loop pump operation. |
| | | PRIM GLY DISCH PRESS ind - 40-52 psig | 2 | |
| | | PRIM ACCUM QTY ind - 30-65% | | |
| | | GLY EVAP STM AUTO - AUTO | | |
| | 10 | Rad htrs | | |
| | | RAD PRIM HTR - redundant htr | | Switch to heater opposite that on at beginning of test. "On" time of heater is function of radiator outlet temperature and is cyclic in nature. Verification requires radiator outlet temperature at -15°F. |

### 4.5.4.3 CO2 Absorber Filter Replacement

**CAUTION**

Conn grd wire when removing or replacing filters from cstr or stowage.

| STA/T | STEP | PROCEDURE | PANEL |
|---|---|---|---|
| CMP | | Obtain unused filter | |

| Filter No. | Stowage Container | Filter No. | Stowage Container | Filter No. | Stowage Container |
|---|---|---|---|---|---|
| 1 | Cstr A | 12 | A9 | 23 | A4 |
| 2 | Cstr B | 13 | A9 | 24 | A4 |
| 3 | B5 | 14 | A9 | 25 | A5 |
| 4 | B5 | 15 | A1 | 26 | A5 |
| 5 | B5 | 16 | A1 | 27 | A5 |
| 6 | B5 | 17 | A3 | 28 | A5 |
| 7 | B6 | 18 | A3 | 29 | A6 |
| 8 | B6 | 19 | A3 | 30 | A6 |
| 9 | B6 | 20 | A3 | 31 | A6 |
| 10 | B6 | 21 | A4 | 32 | A6 |
| 11 | A9 | 22 | A4 | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | Open CO2 cstr atten pnl | 2 | |
| | | CO2 CSTR DIVERT vlv - up (or dn) | 350 | Handle placed up for canister B filter change, down for canister A filter change. |
| | | CAUTION<br>Apply press to latching handle to allow press interlock pin to withdraw, otherwise latching handle may not disengage. | | |
| | | Cstr man bleed vlv - press | | |
| | | Cover latching handle - unlock | | |
| | | Replace used filter | | |
| | | Cover latching handle - lock | | |
| | | CO2 CSTR DIVERT vlv - ctr | | |
| | | Close CO2 cstr atten pnl | | |
| | | Stow used filter | | |
| | | Stow excess shims in volume B5 or B6 | | Space is available for four shims at each end of volume B5 and B6. |
| | 4.5.4.4 | Debris Screen Check | | Lint or other debris on screens may reduce flow substantially. |
| | a. | SUIT RETURN vlv screen<br>Open cool cont atten pnl | 380 | Covers panel 382 and SUIT RETURN valve screen. |
| | | WARNING<br>SUIT FLOW RELF vlv must remain OFF throughout msn or swelling of CO2 odor absorber filters may result. | 382 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | If debris is present | | |
| CDR | | SUIT RETURN vlv - close (push) | 380 | |
| CMP | | Clean screens | | |
| CDR | | SUIT RETURN vlv - open (pull) | | |
| CMP | | Close cool cont atten pnl | | |
| | b. | Cab ht exch inlet screen | | |
| | | CAB FAN (both) - OFF (verify) | 2 | |
| | | Check cab ht exch inlet screen | | |
| | | If debris present - clean screen | | |
| | 4.5.4.5 | Potable Water Chlorination | | Chlorine concentration must not exceed 6 ppm. |
| | | CAUTION<br>If waste water qty is approaching empty (reads ≤15%) & either gly evap is in oper, chlor procedure will not be performed, as impairment of evap efficiency may result. | | |
| | 1 | Check POT H20 QTY ind - if >90%, withdraw 8 oz of water | | It is necessary to withdraw water to allow space for water flow into the tank after chlorine and buffer injection. |
| | 2 | Retrieve chlor unit | | Stowed in compartment B4. |
| | 3 | Remove chlor port cap | | |
| | 4 | Attach needle assy to inj port | | |
| | 5 | Insert chlor ampoule into casing | | Chlorine ampoules color-coded red. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 6 | Conn knob assy & rot (CW) until piston contacts ampoule | | |
| | 7 | Install ampoule assy on needle assy (push & turn CW) | 352 | |
| | | **CAUTION**<br>If potable water qty is <50%, inj half the contents of each ampoule (chlor & buffer) by rotating knob three turns (CW). | | |
| | 8 | Rot knob (CW) until ampoule is empty (piston bottoms out) | | Requires ≈5-1/2 turns. |
| | 9 | Disconnect ampoule assy from needle assy (push & turn CCW) | | |
| | 10 | Rot knob (CCW), remove & stow used ampoule | | Place used ampoule in chlorination unit stowage bag. |
| | 11 | Repeat steps 5 thru 8 using buffer ampoule | | Buffer ampoules color-coded brown. |
| | 12 | Wait 10 min, remove ampoule of H20 by rotating inj barrel (CCW) four turns while holding bayonet section in locked position (CW) | | |
| | 13 | Rot knob (CCW), remove & stow used ampoule | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 14 | Stow chlor unit | | |
| | 15 | Replace chlor port cap | | |
| | | CAUTION<br>Wait 30 min before withdrawing water from water use ports. | | |
| | 4.5.4.6 | PGA Mode Changes | | |
| | | a. PGA to Shirtsleeve | | Two flow paths exist for returning cabin atmosphere to suit circuit for scrubbing. |
| | | CAB PRESS ind - >4.7 psia (verify) | 2 | |
| | | EMER CAB PRESS sel - BOTH | 351 | |
| ALL | | Doff & stow gloves & helmet | | |
| | | If suit return vlv is used | | |
| CDR | | SUIT RETURN vlv - open (pull) | 380 | |
| ALL | | Retrieve inflight coveralls | | |
| | | SUIT PWR - OFF | 9,10,6 | |
| | | PWR - OFF | | |
| | | AUDIO CONT - NORM | | |
| | | WARNING<br>If comm umb is to be disconnected at bulkhead or cont head, VHF AM sw on associated pnl must be placed OFF & S BD MODE PCM sw must be in PCM or ctr. | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| ALL | Disconnect 02 & comm umb at PGA & insert interconnect in 02 return hose | | |
| | If suit return vlv is not used | | |
| | Retrieve inflight coveralls | | |
| | SUIT PWR - OFF | 9,10,6 | |
| | PWR - OFF | | |
| | AUDIO CONT - NORM | | |
| CDR | DEMAND REG sel - OFF | 380 | Screens plus hose causes increased pressure drop in suit circuit causing 02 demand flow. |
| | **WARNING**<br>If comm umb is to be disconnected at bulkhead or cont head, VHF AM sw on associated pnl must be placed OFF & S BD MODE PCM sw must be in PCM or ctr. | | |
| ALL | Disconnect 02 & comm umb at PGA & install suit return hose screen cap | | Suit donning and suit loop isolation requires additional time for repositioning suit flow valves (inaccessible from couches) in addition to normal suiting time. |
| | SUIT FLOW vlv - CAB FLOW (for unsuited crewmen) | 300,301,302 | Adjust suit flow valve between CAB FLOW and FULL FLOW to maintain adequate flow for suited crewman. |
| | Disconnect UTCA, comm & biomed conn | | |
| | Doff & stow UTCA & PGA | | |
| | Don inflight coveralls | | |
| | Retrieve & conn CWG adapter to comm & biomed conn | | |
| | Audio pnl sw (all) - as desired | 9,10,6 | Comm and biomed integrity should be verified. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | b. Shirtsleeve to PGA | | Two flow paths exist for returning cabin atmosphere to suit circuit for scrubbing. |
| ALL | SUIT PWR - OFF<br>PWR - OFF<br>AUDIO CONT - NORM | 9,10,6 | |
| | WARNING<br>If comm umb is to be disconnected at bulkhead or cont head, VHF AM sw on associated pnl must be placed OFF & S BD MODE PCM sw must be in PCM or ctr. | | |
| | Disconnect & stow CWG adapter<br>Doff & stow inflight coveralls<br>Retrieve & don UTCA & PGA, conn UTCA, comm & biomed conn<br>If suit return vlv is used<br>Remove 02 umb interconnect & conn 02 & comm umb to PGA | | |
| CDR | SUIT RETURN vlv - close (push) (if all suited) | 380 | |
| ALL | If suit return vlv is not used<br>Remove suit ckt return hose screen cap & conn 02 & comm umb | | Suit donning and suit loop isolation requires additional time for repositioning suit flow valves (inaccessible from couches) in addition to normal suiting time. |
| CDR | DEMAND REG sel - BOTH | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| ALL | | SUIT FLOW vlv - FULL FLOW (for suited crewman) | 300,301,302 | |
| | | Audio pnl sw (all) - as desired | 9,10,6 | Comm and biomed integrity should be verified. |
| | | Retrieve & don helmet & gloves | | |
| CMP | | EMER CAB PRESS sel - OFF (if all suited) | 351 | |
| | c. | PGA to Partial PGA | | Two flow paths exist for returning cabin atmosphere to suit circuit for scrubbing. |
| | | CAB PRESS ind - >4.7 psia (verify) | 2 | |
| | | EMER CAB PRESS sel - BOTH | | |
| ALL | | Doff & stow gloves & helmet | | |
| | | If suit return vlv is used | | |
| CDR | | SUIT RETURN vlv - open (pull) | 380 | |
| ALL | | Reverse 02 umb conn at PGA | | 02 umbilicals reversed for optimum flow distribution within PGA. |
| | | Supply hose to outlet conn | | |
| | | Return hose to inlet conn | | |
| | | If suit return vlv is not used | | |
| CDR | | DEMAND REG sel - OFF | | Screens plus hose cause increased pressure drop in suit circuit causing 02 demand flow. |
| ALL | | Disconnect return hose from PGA & install suit return hose screen cap | | |
| | | Conn supply hose to outlet conn | | |
| | d. | Shirtsleeve to EVT/IVT | | Two flow paths exist for returning cabin atmosphere to suit circuit for scrubbing. |
| CDR,LMP | | SUIT PWR - OFF | 9,6 | |
| | | PWR - OFF | | |
| | | AUDIO CONT - NORM | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | WARNING<br>If comm umb is to be disconnected at bulkhead or cont head, VHF AM sw on associated pnl must be placed OFF & S BD MODE PCM sw must be in PCM or ctr. | | |
| CDR,LMP | Disconnect & stow CWG adapter | | |
| | Doff & stow inflight coveralls | | |
| | Doff CWG | | Stow LMP CWG. |
| | Don fecal containment system | | |
| CDR | Don CWG | | |
| LMP | Retrieve & don LCG | | |
| CDR,LMP | Don comm carrier/moulded earpiece adapters | | |
| | Retrieve & don UCTA & PGA, conn UCTA, comm, & biomed conn | | |
| | If suit return vlv is used | | |
| | Remove 02 umb interconnect & conn 02 & comm umb | | |
| CDR | SUIT RETURN vlv - close (push) (if all suited) | 380 | |
| | If suit return vlv is not used | | |
| CDR,LMP | Remove suit return hose screen cap & conn 02 & comm umb | | Suit donning and suit loop isolation requires additional time for repositioning suit flow valves (inaccessible from couches) in addition to normal suiting time. |
| | SUIT FLOW vlv (2) - FULL FLOW | 300,301 | |
| | Audio pnl sw (all) - as desired | 9,6 | Comm and biomed integrity should be verified. |
| | Retrieve & don helmet & gloves | | |
| CMP | EMER CAB PRESS sel - OFF (if all suited) | 351 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.5.4.7 Waste Management Procedures | | |
| | WARNING<br>If germicide pouch is accidently ruptured, proceed as follows:<br>● Germicide on CM surface or hardware; wipe up with tissue.<br>● Germicide on crewman's skin; blot with tissue and flush with water.<br>● Germicide in crewman's eyes; irrigate with water from water gun or soaked tissue.<br>● Germicide ingested; take magnesium compound and/or high protein food - do not induce vomiting. | | |
| | a. Urine Dump Modes | | |
| ALL | (1) PGA urine collection bag | | |
| | Conn urine line filter to urine trnfr hose | | Filter stowed in R-5, hose under A-6. |
| | Conn urine trnfr hose/filter to urine/feces QD | | |
| | Remove cap from PGA thigh QD & stow | | Temporary stowage. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| ALL | Conn urine trnfr hose/filter QD to thigh QD | | |
| | OVBD DRAIN vlv - DUMP | 251 | |
| | When PGA bag empty, disconnect urine trnfr hose/filter QD at PGA thigh QD | | |
| | Replace cap on PGA thigh QD | | |
| | Conn UTS to urine trnfr hose/filter QD | | Stowed in R-11. |
| | UTS vlv - open | | |
| | Purge until particles cease exhausting vent line (1 to 2 min), then OVBD DRAIN vlv - OFF | | |
| | UTS vlv - close | | |
| | Disconnect UTS from urine trnfr hose & stow | | Stowed in R-11. |
| | Disconnect urine trnfr hose from urine/feces QD & stow | | Stow filter in R-5, hose under A-6. |
| (2) | UTS (collection) | | Used when inconvenient for simultaneous urination and overboard dumping. |
| | Obtain UTS & verify vlv closed | | Stowed in R-11. |
| | Roll cuff - affixed | | |
| | UTS vlv - open | | |
| | Perform task | | Six spare roll-on cuffs stowed in medical accessory kit (B2), and one spare receiver assembly stowed in R-11. |
| | UTS vlv - close | | |
| | Roll cuff - removed | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| ALL | Free urine in cuff absorbed with tissue | | |
| | UTS - stow (temporary) | | |
| | When convenient, dump urine by UTS (dump) proced | | |
| (3) | UTS (dump) | | |
| | Conn urine line filter to urine trnfr hose | | Filter in R-5, hose under A-6. |
| | Conn urine trnfr hose/filter to urine/feces QD | | |
| | Obtain UTS & verify vlv closed | | Stowed in R-11. |
| | Attach UTS to urine trnfr hose | | |
| | Perform UTS (collection) (if req), 4.5.4.7a (2) | | |
| | OVBD DRAIN vlv - DUMP | 251 | |
| | When UTS bag empty, UTS vlv - open | | |
| | Purge 30 sec (min), then OVBD DRAIN vlv - OFF | | |
| | UTS vlv - close | | |
| | Disconnect UTS from urine trnfr hose & stow | | Stow in R-11. |
| | Disconnect urine trnfr hose from urine/feces QD & stow | | Stow filter in R-5, hose under A-6. |
| (4) | Urine Receptacle Assy (URA) | | GFE assembly. |
| | Conn urine line filter to urine trnfr hose | | |
| | Conn urine trnfr hose/filter to urine feces QD | | |
| | Conn urine receptacle to urine trnfr hose | | |
| | URA vlv - VENT | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| ALL | Remove receptacle cover | | |
| | OVBD DRAIN vlv - DUMP | 251 | |
| | Perform task | | Direct urine stream parallel to honeycomb to prevent splashback. Avoid accelerations to URA during use. Remove last drop by touching screen at top of URA. |
| | Flush screen & honeycomb with water gun | | |
| | Replace receptacle cover after liquid has cleared from URA | | |
| | URA vlv - CLOSE (CW) | | |
| | Stow URA for next use with urine trnfr hose conn & OVBD DRAIN vlv - DUMP | | Allows URA to vacuum dry between uses. |
| | For stowage prior to entry | | |
| | OVBD DRAIN vlv - OFF | | |
| | Remove & stow URA, urine trnfr hose & urine filter | | Stow in A-8. |
| | b. Defecation | | |
| | Remove fecal collection assy from stowage | | Assemblies stowed in compartment R-10. |
| | Obtain defecation collection device from assy | | |
| | Remove germicide pouch | | |
| | Insert germicide pouch (protective cover removed) into inner fecal bag | | |
| | Remove protective covering from lip of inner fecal bag & place into bag | | Lip of inner fecal bag covered with adhesive. |
| | Affix inner fecal bag | | |
| | Perform task | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| ALL | Seal inner fecal bag | | Remove air prior to sealing. |
| | Rupture germicide pouch | | |
| | Knead contents for 4 min | | |
| | Insert into outer fecal bag | | |
| | Only subsequent to initial odor detection will waste stowage compartment be vented prior to each waste deposit | | |
| | WASTE STOW vlv - VENT for 30 sec, then CLOSE | 252 | |
| | Stow fecal bag | | Fecal matter stowed in waste stowage compartment. |
| c. | Emesis | | |
| | Obtain fecal/emesis (F/E) bag | | |
| | Perform task | | |
| | Insert germicide pouch (protective cover removed) into inner F/E bag | | |
| | Seal inner F/E bag | | |
| | Rupture germicide pouch | | |
| | Insert inner F/E bag into outer F/E bag & seal | | |
| | Only subsequent to initial odor detection will waste stowage compartment be vented prior to each waste deposit | | |
| | WASTE STOW vlv - VENT for 30 sec, then CLOSE | | |
| | Stow outer F/E bag | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | d. Side Hatch Urine/Water Dump | | Cable and quick-disconnects stowed in Volume R-10. |
| CMP | Remove dump nozzle conn cover | Side hatch | Use tool E. Rotate cover as necessary to permit removal of electrical connector. Connector lock pins must be aligned with slots (3) in threaded portion of cover. |
| | Remove plug & stow | | Use tool E. Plug stowed in Volume R-10. |
| | Withdraw wire guard & wires from slot | | Wire guard to hang loose on wiring. |
| | Install male QD on dump nozzle (finger-tight) | | |
| | Conn cable to htr conn (if req) | | The side hatch dump nozzle heater need not be connected (crew option). CM orientation and previous cold soak should be considered when electing not to connect heater. If nozzle freezes, connect and use heater to thaw nozzle. |
| | UTIL PWR - OFF (verify) | 16 | |
| | Conn cable to outlet | | |
| | UTIL PWR - on (up) | | |
| | If urine ovbd dump req | | |
| | Conn urine dump hose to dump nozzle QD | | Cabin to ambient $\Delta P$ will provide for urine flow. |
| | If waste H20 ovbd dump req | | |
| | Install female QD on waste H20 servicing conn | 352 | Use tool F to remove connector cap. |
| | Conn urine dump hose to servicing conn & dump nozzle | | |
| LMP | H20 QTY IND sw - WASTE | 2 | |
| CMP | WASTE TK SERV vlv - OPEN until WASTE H20 QTY ind - ≈25%, then CLOSE | 352 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | CAUTION | | |
| | | Depletion of all waste water may damage suit heat exchanger water separator. | | |
| | e. | Water Collection | | |
| CMP | | Conn urine trnfr hose-filter to urine/feces QD | 251 | |
| | | Conn cab purge QD to urine trnfr hose | | |
| | | OVBD DRAIN vlv - DUMP | | |
| | | Collect water | | |
| | | After collection is complete | | |
| | | Purge until particles cease exhausting vent line (1 to 2 min) | | |
| | | OVBD DRAIN vlv - CLOSE | | |
| | f. | Vac Oper Using O2 Umb | | |
| | | CAUTION | | |
| | | Not to be used for H2O collection. Ingestion of H2O will cause swelling of CO2 cstr element. | | |
| CDR | | DEMAND REG sel - OFF | 380 | Screens plus hose cause increased pressure drop in suit circuit causing O2 demand flow. |
| | | SUIT RETURN vlv - close (push) | | |
| ALL | | Install one screen & one interconnect to two return hoses | | |
| | | Install vac brush to third return hose | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| ALL | SUIT FLOW vlv (3) - FULL FLOW | 300,301,302 | |
| | At completion of vac | | |
| CDR | SUIT RETURN vlv - open (pull) | 380 | |
| | DEMAND REG sel - BOTH | | |
| ALL | SUIT FLOW vlv (3) - CAB FLOW | 300,301,302 | |
| LMP | Remove vac brush & install screen cap on return hose | | |
| 4.5.4.8 | CM Repressurization | | |
| a. | Norm Mode (time ≈21 min) | | |
| CDR | CAB PRESS RELF vlv (2) - NORM (safety latch on) | 325 | |
| CMP | CAB PRESS DUMP vlv - close (CW) (verify) | Side hatch | |
| LMP | O2 PRESS IND sw - SURGE TK | 2 | |
| CDR | REPRESS PKG vlv - FILL | 326 | |
| | REPRESS O2 - OPEN | 601 | Guarded. |
| LMP | CRYO O2 PRESS 1 ind - 150 psia min | 2 | Minimum surge tank pressure. |
| CDR | REPRESS PKG vlv - OFF | 326 | |
| LMP | CAB PRESS ind - 3.0 psia (in 1 min) | 2 | |
| | REPRESS O2 PRESS ind - 0.0 psig | 602 | |
| CDR | REPRESS O2 - CLOSE | 601 | Guarded. |
| CMP | CAB REPRESS vlv - open (CW) | 351 | Maintain 150 psia minimum in surge tank. |
| LMP | CAB PRESS ind - 4.7-5.3 psia | 2 | |
| | O2 PRESS IND sw - TK 1 | | |
| CMP | CAB REPRESS vlv - OFF (CCW) | 351 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | b. Alternate Mode (time ≈48 min) | | |
| CDR | CAB PRESS RELF vlv (2) - NORM (safety latch on) | 325 | |
| CMP | CAB PRESS DUMP vlv - close (CW) (verify) | Side hatch | |
| | EMER CAB PRESS sel - BOTH | 351 | |
| | CAB REPRESS vlv - open (CW) | | |
| LMP | O2 PRESS IND sw - SURGE TK | 2 | |
| | CRYO O2 PRESS 1 ind - 150 psia min | | Minimum surge tank pressure. |
| CMP | EMER CAB PRESS sel - OFF | 351 | |
| | CAB REPRESS vlv - adj to 150 psia min | | |
| LMP | CAB PRESS ind - 4.7-5.3 psia | 2 | |
| | O2 PRESS IND sw - TK 1 | | |
| CMP | CAB REPRESS vlv - OFF (CCW) | 351 | |
| 4.5.4.9 | Pressure Suit Circuit & PGA Check at 5.0 psia | | |
| | a. Gross Suit Ckt Verification | | This procedure may be used in lieu of step b, PGA Check Only, to ascertain complete suit loop integrity. |
| CDR | DIRECT O2 vlv - close (CW) | 7 | |
| CMP | SUIT PRESS ind - 4.7-5.3 psia | 2 | |
| | O2 FLOW ind - 0.2-0.4 lb/hr | | |
| | **CAUTION** | | |
| | • SUIT TEST vlv should remain in PRESS position until suit ckt press is stab to preclude seal scarring. | | |

...continued

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | ● If repositioning of SUIT TEST vlv from PRESS is req prior to suit press stabilization, perform the following: | | |
| CDR | | a. DEMAND REG sel - OFF | 380 | |
| | | b. Allow 15 sec (min) stabilization time | | |
| | | c. Reposition SUIT TEST vlv - DEPRESS or OFF as applicable | | |
| | | d. When suit press stabilized, DEMAND REG sel - BOTH | | |
| | | SUIT TEST vlv - PRESS | | All crewmen exercise PGA joints during pressurization period. DIRECT 02 valve may be slightly opened to reduce suit loop pressurization time, but must be fully closed (CW) at 4.0 psig suit pressure. |
| CMP | | 02 FLOW ind - 1.0 lb/hr (pegged) | 2 | |
| | | 02 FLOW HI lt - on | | After 16-second delay. |
| ALL | | MASTER ALARM pb/lt (3) - on, push | 1,3,122 | |
| CDR | | Cycle SUIT RETURN vlv - open (pull) & close (push) when PGA press ind - 1.5-2.0 psig | 380 | Continue suit circuit pressurization until 02 flow starts to decrease. |
| CMP | | SUIT PRESS ind - 8.8-9.8 psia | 2 | Crewmen remain inactive while monitoring suit circuit pressure and 02 flow indicator to preclude fluctuations in 02 flow. Monitoring should not be scheduled during H20 accumulator stroking (or 30 seconds thereafter), or accumulators should be temporarily disabled during test (SUIT H20 ACCUM AUTO - center, then back to previous position). |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| ALL | PGA press ind (3) - 4.1-4.5 psig | PGA | |
| CMP | 02 FLOW HI lt - out | 2 | |
| | 02 FLOW ind - stab for 15 sec, & remain <0.8 lb/hr for 30 sec after stabilization | | |
| CDR | SUIT TEST vlv - DEPRESS | 380 | |
| CMP | 02 FLOW ind - 0.2-0.4 lb/hr | 2 | |
| | SUIT PRESS ind - slightly >CAB PRESS ind | | In ≈75 seconds. |
| CDR | SUIT TEST vlv - OFF | 380 | |
| | DEMAND REG sel - BOTH (verify) | | |
| | b. PGA Check Only | | This procedure is performed only if individual or collective PGA verification is required. |
| | DIRECT 02 vlv - close (CW) | 7 | |
| CMP | SUIT PRESS ind - 4.7-5.3 psia | 2 | |
| | 02 FLOW ind - 0.2-0.4 lb/hr | | |
| | **CAUTION** | | |
| | SUIT TEST vlv should remain in PRESS position until suit ckt press is stab to preclude seal scarring. | | |
| CDR | SUIT TEST vlv - PRESS | 380 | All crewmen exercise PGA joints during pressurization period. DIRECT 02 valve may be slightly opened to reduce suit loop pressurization time, but must be fully closed (CW) at 4.0 psig suit pressure. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | O2 FLOW ind - 1.0 lb/hr (pegged)<br>O2 FLOW HI lt - on | 2 | |
| ALL | MASTER ALARM pb/lt (3) - on, push | 1,3,122 | |
| CMP | SUIT PRESS ind - 8.8-9.8 psia | 2 | After ≈75 seconds. |
| ALL | PGA press ind (3) - 4.1-4.5 psig | PGA | |
| | **WARNING**<br>Suit flow vlv(s) may remain in OFF position for no longer than one min or asphyxiation may result. | | |
| | **CAUTION**<br>If all suit flow vlvs are closed simultaneously, suit comprs must be shut off to prevent compr damage due to deadheading of suit loop. | | |
| CMP | SUIT FLOW vlv (suited crewmen) - OFF | 300,301,302 | |
| ALL | PGA press ind (suited crewmen) - <0.5 psi/min press decay | PGA | Crewmen hold breath and remain inactive while monitoring PGA pressure decay to preclude pressure drop or fluctuation on PGA pressure indicators. |
| CMP | SUIT FLOW vlv (suited crewmen) - FULL FLOW | 300,301,302 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | CAUTION | | |
| | | If repositioning of SUIT TEST vlv from PRESS is req prior to suit press stabilization, perform the following: | | |
| CDR | | a. DEMAND REG sel - OFF | 380 | |
| | | b. Allow 15 sec (min) stabilization time | | |
| | | c. Reposition SUIT TEST vlv - DEPRESS or OFF as applicable | | |
| | | d. When suit press stabilization, DEMAND REG sel - BOTH | | |
| | | SUIT TEST vlv - DEPRESS | | |
| CMP | | O2 FLOW HI lt - out | 2 | |
| | | O2 FLOW ind - 0.2-0.4 lb/hr | | |
| | | SUIT PRESS ind - slightly >CAB PRESS ind | | In ≈75 seconds. |
| CDR | | SUIT TEST vlv - OFF | 380 | |
| | 4.5.4.10 | CM O2 Supply Refill | | |
| LMP | | O2 PRESS IND sw - SURGE TK | 2 | |
| | | CRYO O2 PRESS 1 ind - 400 psia | | |
| CMP | | CAB REPRESS vlv - OFF (CCW) | 351 | |
| CDR | | REPRESS O2 - CLOSE | 601 | Guarded. |
| | | REPRESS PKG vlv - FILL | 326 | |
| CMP | | CRYO O2 PRESS 1 ind - 865-935 psia | 2 | Monitor pressure to assure no decrease below 150 psia. |
| | | O2 PRESS IND sw - TK 1 | | Upon completing refill operation. |
| CDR | | REPRESS PKG vlv - OFF | 326 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.5.4.11 CM Pressure Dump | | |
| | a. Using Cab Press Relf Vlv | | |
| CMP | CAB FAN (both) - OFF (verify) | 2 | |
| CDR | DIRECT 02 vlv - close (CW) | 7 | |
| | rh CAB PRESS RELF vlv - DUMP (safety latch off) | 325 | Valve in DUMP position long enough for cabin pressure to decrease to ≈3.25 psia. |
| CMP | CAB PRESS ind - 3.0-3.25 psia | 2 | |
| CDR | rh CAB PRESS RELF vlv - BOOST/ENTR | 325 | |
| CMP | 02 FLOW ind - ≈0.24 lb/hr | 2 | Verifies cabin pressure regulator lockout. |
| | SUIT PRESS ind - 3.5-4.0 psia | | Verifies suit demand pressure regulator aneroid function. |
| CDR | rh CAB PRESS RELF vlv - DUMP | 325 | |
| CMP | CAB PRESS ind - 0.0 psia (within 6 min) | 2 | Cabin at 0.01 psia within 4.5 minutes. |
| CDR | CAB PRESS RELF vlv (2) - NORM (safety latch on) | 325 | |
| | b. Using Side Hatch Cab Press Dump Vlv | | |
| LMP | CAB FAN (both) - OFF (verify) | 2 | |
| CMP | EMER CAB PRESS sel - OFF | 351 | |
| CDR | REPRESS PKG vlv - OFF | 326 | |
| | If lone crewman oper<br>REPRESS PKG vlv - FILL | | REPRESS PKG valve should be in FILL position for lone crewman activities, as leaving valve in OFF reduces immediate repressurization capability to ≈1.8 psia, less than amount required to sustain life if suit ruptures. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | REPRESS 02 vlv - CLOSE | 601 | |
| CDR | DIRECT 02 vlv - close (CW) (verify) | 7 | |
| LMP | CAB PRESS DUMP vlv - open (CCW - one turn) | Side hatch | Valve in open position long enough for cabin pressure to decrease to ≈3.25 psia. |
| | CAB PRESS ind - 3.0-3.25 psia | 2 | |
| | CAB PRESS DUMP vlv - close (CW) | Side hatch | |
| | 02 FLOW ind - <0.5 lb/hr | 2 | Verifies cabin pressure regulator lockout and that EMER CAB PRESS selector is OFF. |
| | SUIT PRESS ind - 3.5-4.0 psia | | Verifies suit demand pressure regulator aneroid function. |
| | CAB PRESS DUMP vlv - open (CCW) | Side hatch | Full open. |
| | CAB PRESS ind - ≈0 psia | 2 | |
| | CAB PRESS DUMP vlv - close (CW) | Side hatch | |
| 4.5.4.12 | Suit Circuit Purge of H2 | | |
| CDR | DIRECT 02 vlv - OPEN (CCW) for 1 min | 7 | Suit circuit pressure relief valve dumps hydrogen into cabin. |
| CMP | 02 FLOW ind - 1.0 lb/hr (pegged) | 2 | |
| | 02 FLOW HI lt - on | | After 16-second time delay. |
| ALL | MASTER ALARM pb/lt (3) - on, push | 1,3,122 | |
| CDR | DIRECT 02 vlv - close (CW) | 7 | |
| CMP | 02 FLOW HI lt - out | 2 | |
| | 02 FLOW ind - 0.2 lb/hr (pegged) | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.5.4.13 Cabin Cold-Soak Operation | | Secondary glycol loop placed in evaporative cooling mode, and routed only to suit circuit heat exchanger. |
| | a. Activate Cold Soak | | |
| CMP | Open cool cont atten pnl | | Covers panel 382. |
| | **WARNING** | | |
| | SUIT FLOW RELF vlv must remain OFF throughout mission or swelling of CO2 odor absorber filters may result. | 382 | |
| | SUIT HT EXCH SEC GLY - FLOW | | |
| | SEC EVAP H2O CONT vlv - AUTO | | |
| | Close cool cont atten pnl | | |
| LMP | CAB TEMP - MAN | 2 | |
| CMP | PRIM CAB TEMP vlv - COLD (CW) | 303 | Maximum cold position. |
| | SEC CAB TEMP vlv - OFF (CCW) | | Bypass cabin heat exchanger. |
| LMP | SUIT HT EXCH - BYP for 20 sec, then off (ctr) | 2 | |
| | ECS IND sel - SEC | | |
| | SEC COOL PUMP - AC1 | | |
| | SEC GLY DISCH PRESS ind - 39-51 psig | | After initiating cold-soak operation, periodic ECS monitoring check should include readings from the following secondary loop indicators: SEC GLY EVAP OUT TEMP, SEC GLY EVAP STM PRESS, SEC GLY DISCH PRESS, and SEC ACCUM QTY. |
| | SEC ACCUM QTY ind - 30-55% | | |
| | SEC COOL EVAP - EVAP | | |
| | SEC GLY EVAP OUT TEMP ind - 38°-50.5°F | | |
| | SEC GLY EVAP STM PRESS ind | | |
| | When boiling - 0.09-0.14 psia | | |
| | Not boiling - >0.14 psia | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| LMP | | ECS IND sel - PRIM | 2 | |
| | | RAD PRIM OUT TEMP ind - >-20°F | | |
| | | If <-20°F | | Cold soak operation is stopped until RAD PRIM OUT TEMP indicator - >0°F. |
| | | SEC COOL EVAP - RSET for 58 sec min, then off (ctr) | | |
| | | SEC COOL PUMP - off (ctr) | | |
| | | SUIT HT EXCH - ON for 20 sec, then off (ctr) | | |
| | b. | Deactivate Cold Soak | | |
| CMP | | SEC CAB TEMP vlv - MAX COOL (CW) | 303 | |
| LMP | | CAB TEMP - AUTO | 2 | |
| | | SUIT HT EXCH - ON for 20 sec, then off (ctr) | | |
| | | SEC COOL EVAP - RSET for 58 sec min, then off (ctr) | | RSET closes steam pressure control valve. Steam pressure valve requires 58 seconds from full open to full close. |
| | | SEC COOL PUMP - off (ctr) | | |
| CMP | | Open cool cont atten pnl | | |
| | | WARNING | | |
| | | SUIT FLOW RELF vlv must remain OFF throughout msn or swelling of C02 odor absorber filters may result. | 382 | |
| | | SEC EVAP H20 CONT vlv - OFF | | |
| | | Close cool cont atten pnl | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.5.4.14 | CM/LM Pressure Equalization | | |
| ALL | a. | Vented LM<br>PGAs donned & checked (refer to PGA Mode Changes, 4.5.4.6, & Pressure Suit Circuit & PGA Check at 5.0 psia, 4.5.4.9) | | LM overhead hatch pressure dump valve open at launch. This procedure requires ≈30 minutes to complete. |
| CMP | | WASTE STOW vlv - CLOSE | 252 | Required for transposition, docking, and LM ejection only. |
| LMP | | 02 PRESS IND sw - SURGE TK<br>CRYO 02 PRESS 1 ind & REPRESS 02 PRESS ind - 865-935 psia (verify) | 2 | |
| CMP | | EMER CAB PRESS sel - OFF (verify) | 351 | At reduced cabin pressure, unnecessary 02 consumption will occur if EMER CAB PRESS selector is not OFF. |
| CDR | | REPRESS PKG vlv - OFF | 326 | |
| | | CAUTION<br>Do not exceed cab press of 5.7 psia or cab press relf vlv will actuate. | | |
| | | DIRECT 02 vlv - OPEN (CCW) | 7 | |
| LMP | | 02 FLOW ind - 1.0 lb/hr (pegged)<br>02 FLOW HI lt - on | 2 | |
| ALL | | MASTER ALARM pb/lt (3) - on, push | 1,3,122 | |
| LMP | | SUIT CAB ΔP ind - >+2.0 in. H20<br>CAB PRESS ind - ≈5.7 psia | 2 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | DIRECT 02 vlv - close (CW) | 7 | Cabin pressure should increase to ≈5.7 psia in ≈2 minutes. Surge tank pressure will decrease to ≈550 psia. |
| CMP | TUNL VENT vlv - LM/CM ΔP (verify)<br>LM/CM ΔP ind - +4 psid (pegged) after 27.5 min | 12 | |
| LMP | CRYO 02 PRESS ind - 850 psia | 2 | Surge tank pressure will increase from 550 psia to 850 psia in ≈27.5 minutes after DIRECT 02 valve is closed. |
| CMP | PRESS EQUAL vlv - OPEN | Fwd hatch | |
| | If unable to open PRESS EQUAL vlv, inform MSFN | | Applicable to transposition, docking, and LM ejection. SIVB life limit does not permit alternate pressure equalization through TUNL VENT valve. |
| | CM Pressure Dump, 4.5.4.11a<br>Continue prep for LM ejection using pressurized PGAs<br>CM Repressurization, 4.5.4.8a | | |
| | or TUNL VENT vlv - LM PRESS | 12 | TUNL VENT valve requires ≈10 hours to pressurize tunnel and LM. |
| LMP | CAB PRESS ind - 4.5 psia | 2 | |
| | PRESS EQUAL vlv - CLOSE | Fwd hatch | |
| CMP | LM/CM ΔP ind - ≈3.1 psid<br>Mon LM/CM ΔP ind for 3 min & verify ΔP stable | 12 | |
| LMP | PRESS EQUAL vlv - OPEN | Fwd hatch | |
| | CAB PRESS ind - 4.0 psia | 2 | |
| CMP | REPRESS 02 - OPEN | 601 | |
| LMP | CAB PRESS ind - 5.7 psia (max) | 2 | Anticipated cabin pressure will be ≈5.0 psia. |

4.5.4.14

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | Cycle REPRESS 02 as req between 4.0 & 5.7 psia limits until REPRESS 02 PRESS ind - ≈0.0 psia | 601 | |
| | REPRESS 02 - CLOSE | | LM and CM cabin should be equalized in pressure when REPRESS 02 bottles are empty. If not, excessive tunnel or LM cabin leakage is indicated. |
| LMP | CAB PRESS ind - ≥4.0 psia | 2 | |
| CMP | LM/CM ΔP ind - ≈0.0 psid | 12 | Permissible to proceed with hatch removal. |
| LMP | CAB PRESS ind does not stab above 4.0 psia & LM/CM ΔP ind - ≥0.0 psid | 2 | Pressure will continue to increase automatically through cabin pressure regulator. |
| CMP | PRESS EQUAL vlv - CLOSE | Fwd hatch | |
| | PRESS EQUAL vlv opened periodically as CM press incr thru cab press until press is equalized at or above 4.0 psia | | |
| LMP | CRYO 02 PRESS 1 ind - 400 psia | 2 | |
| CDR | REPRESS PKG vlv - FILL until | 326 | |
| LMP | CRYO 02 PRESS 1 ind & | 2 | |
| CMP | REPRESS 02 PRESS ind - 865-935 psia | 602 | |
| CDR | REPRESS PKG vlv - OFF | 326 | |
| CMP | EMER CAB PRESS sel - BOTH | 351 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | **CAUTION**<br>TUNL VENT vlv should not be inadvertently left in LM PRESS position when CM & LM are separated, as 02 would be vented to amb thru a 1/4-inch line. | | |
| CMP | | TUNL VENT vlv - OFF | 12 | |
| | | WASTE STOW vlv - VENT | 252 | Required for transposition, docking, and LM ejection only. |
| | b. | Pressurized LM | | |
| | | PGA donned & checked (refer to PGA Mode Changes, 4.5.4.6, & Pressure Suit Circuit & PGA Check at 5.0 psia, 4.5.4.9) | | |
| LMP | | 02 PRESS IND sw - SURGE TK | 2 | |
| | | CRYO 02 PRESS 1 ind - 865-935 psia (verify) | | |
| CMP | | EMER CAB PRESS sel - OFF (verify) | 351 | At reduced cabin pressure, unnecessary 02 consumption will occur if EMER CAB PRESS selector is not OFF. |
| CDR | | REPRESS PKG vlv - OFF | 326 | |
| | | DIRECT 02 vlv - OPEN (CCW) | 7 | |
| LMP | | CAB PRESS ind - 5.5 psia | 2 | |
| CDR | | DIRECT 02 vlv - close (CW) until | 7 | |
| LMP | | 02 FLOW ind - <0.5 lb/hr | 2 | |
| CDR | | DIRECT 02 vlv - OPEN (CCW) until 02 flow - 0.6 lb/hr | 7 | |
| CMP | | TUNL VENT vlv - LM/CM ΔP | 12 | |
| | | LM/CM ΔP ind - +4 psid (pegged) | | |
| | | PRESS EQUAL vlv - OPEN | Fwd hatch | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | If unable to open PRESS EQUAL vlv | | |
| CMP | | TUNL VENT vlv - LM PRESS | 12 | |
| | | LM/CM ΔP ind - ≈3 psid | | |
| | | PRESS EQUAL vlv - CLOSE | Fwd hatch | |
| | | LM/CM ΔP ind - mon for 3 min & verify ΔP stable | 12 | |
| | | PRESS EQUAL vlv - OPEN | Fwd hatch | |
| | | LM/CM ΔP ind - 0.0 psid | 12 | |
| | | PRESS EQUAL vlv - CLOSE | Fwd hatch | |
| | | EMER CAB PRESS sel - BOTH | 351 | |
| | | **CAUTION**<br>TUNL VENT vlv should not be inadvertently left in LM PRESS position when CM & LM are separated, as 02 would be vented to amb thru a 1/4-inch line. | | |
| | | TUNL VENT vlv - OFF | 12 | |
| CDR | | DIRECT 02 vlv - close (CW) immediately after hatch close-out | 7 | |
| | 4.5.4.15 | Operation of Emergency 02 Masks | | |
| LMP | | EMER 02 - OPEN | 600 | Masks stowed on aft bulkhead aft of emergency 02 unit. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| ALL | | Don emer O2 masks | AESB | Push mask pushbutton for continuous flow, otherwise mask is demand flow. |
| | | Doff emer O2 masks | | |
| LMP | | EMER O2 - CLOSE | 600 | |
| | 4.5.4.16 | Waste Water Tank Drain | | |
| | | H2O QTY IND sw - WASTE | 2 | |
| CMP | | PRESS RELF sel - DUMP A | 352 | |
| LMP | | Mon WASTE H2O QTY ind - decr<br>WASTE H2O QTY ind - ≈25% | 2 | |
| | | CAUTION<br>Depletion of all waste water may damage suit heat exchanger water separator. | | |
| CMP | | PRESS RELF sel - 2 | 352 | |
| | 4.5.4.17 | Gas Separator Cartridge Servicing | | |
| | | a. Remove separator cartridge from stowage | | Stowed in volume A1. |
| | | b. Attach separator to water pistol | | Female port of separator will fit on water pistol probe. |
| | | c. Trigger water pistol in short pulses until water is observed at separator outlet port | | |
| | | d. Wait 10 min | | Allow 10 minutes for membrane wetting. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | CAUTION<br>Membrane can be damaged by pencils, screwdrivers, & other pointed objects. | | |
| CMP | e. | Use separator on water pistol or food prep unit as req | 305 | |
| | 4.5.4.18 | Primary Glycol Evaporator Operation | | |
| | 1 | Activate prim evap<br>GLY EVAP H2O FLOW - AUTO<br>GLY EVAP STM AUTO - AUTO | 2 | |
| | 2 | Deactivate prim evap<br>GLY EVAP H2O FLOW - off (ctr)<br>GLY EVAP STM AUTO - MAN<br>GLY EVAP STM INCR - INCR for 58 sec min | | INCR position is momentary. Steam pressure valve requires 58 seconds from full open to full close. |
| | 4.5.4.19 | Cabin Fan Lunar Dust Filter | | |
| | 1 | Filter installation before LM/CM rndz | | As close as is practical to LM/CM rendezvous. |
| | | Unstow filter & install over cab fan outlet (louvers full open) | UEB | Filter stowage bag to remain in position in upper equipment bay adjacent to repress O2 panel. |
| | | Place filter bellows in extd position | | |
| | | CAB FAN (2) - on (up) | 2 | Activated when CM and LM hatches are removed. |
| | 2 | Filter removal after LM/CM rndz | | Cabin fans, with filter in place, to remain in operation for 4 hours after CM and LM hatches removed. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | After 4 hours | | |
| CMP | | CAB FAN (2) - OFF | 2 | |
| | | Place filter bellows in compressed position | | |
| | | Position filter stowage bag over filter | | |
| | | Loosen filter mounting snaps (2) & carefully remove & seal filter in stowage bag | | |
| | | Secure filter stowage bag to top of stowage locker A13 | | |
| | 4.5.4.20 | Lunar Dust Vacuum Cleaner Operation | | The vacuum cleaner assembly may be used in LM as well as CM, because of length of power cable. |
| | | Unstow vac cleaner & associated cmpnts (pwr cable, bag, hose, & brush) | AEB | |
| | | AC UTIL PWR - OFF (verify) | 201 | |
| | | Assemble cmpnts & conn pwr cable to pnl | | |
| | | AC UTIL PWR - on (up) | | |
| | | Vac cleaner pwr sw - ON | | |
| | | At completion of vac cleaner use | | |
| | | Vac cleaner pwr sw - OFF | | |
| | | AC UTIL PWR - OFF | | |
| | | Disconnect pwr cable & disassemble cmpnts | | |
| | | Stow vac cleaner & associated cmpnts | AEB | |

### 4.5.5 CAUTION AND WARNING SYSTEM

**CAUTION**

> Any or all of the system status lights should not be left illuminated for more than 10 minutes or overheating of the matrix will occur.

System management procedures for the C&WS consist of the following:

1. A procedure is provided for an operational test of the detection unit, system status lights, and MASTER ALARM pb/lt and tone. The test may be conducted at any time during the mission at discretion of crew.
2. An adjustment may be made at each orbital sunset to facilitate dark adaptation during period of orbital darkness.
3. Acknowledgement of system status light illumination and resetting of master alarm circuit is required. The procedures apply during prelaunch or any flight phase of the mission.
4. A procedure is provided for inhibiting master alarm tone in each headset, at discretion of the crew.
5. If one or more of the C&WS status lights are illuminated for more than 10 minutes, the status light matrix will become hot to the touch. The Acknowledge Mode may be used to prevent excessive on-time of status lights.
6. Installation procedures and an operational check for stowable C/W tone booster is presented.
7. During normal operations some C/W master alarms may illuminate. These alarms are listed, accompanied by information on what action should be taken to return C/W system to normal.

### 4.5.5.1 C&WS Operational Check

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | C/W LAMP TEST - 1 (hold) | 2 | Position 1 is momentary. Lamp test of MASTER ALARM light on panel 122 accomplished when G&N condition lights on that panel tested. Master alarm tone not activated by this test. |
| CDR | MASTER ALARM pb/lt - on | 1 | |
| CMP | lh C/W lts (15) - on | 2 | |
| | C/W LAMP TEST - 2 (hold) | | Position 2 is momentary. |
| CDR | MASTER ALARM pb/lt - out | 1 | |
| CMP | lh C/W lts (15) - out | 2 | |
| LMP | MASTER ALARM pb/lt - on | 3 | |
| CMP | rh C/W lts (20) - on | 2 | |
| | C/W LAMP TEST - rel | | |
| LMP | MASTER ALARM pb/lt - out | 3 | |
| CMP | rh C/W lts (20) - out | 2 | |
| | C/W CSM - CM | | Master alarm tone activated by this test. |
| | CM RCS lt (both) - on | | Systems 1 and 2 status lights. |
| ALL | MASTER ALARM pb/lt (3) & tone - on | 1,3,122 | MASTER ALARM light on MDC-1 will not come on if C/W NORM switch is in BOOST position. |
| | MASTER ALARM pb/lt - push | | |
| | MASTER ALARM pb/lt (3) & tone - out | | |
| CMP | C/W CSM - CSM | 2 | |
| | CM RCS lt (both) - out | | |

### 4.5.5.2 Dark Adaptation Adjustment

C/W NORM - ACK (at sunset)
C/W NORM - NORM (at sunrise)

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.5.5.3 | Acknowledge/Reset Master Alarm Indication | | |
| | a. | Norm Mode | | |
| ALL | | MASTER ALARM pb/lt (3) & tone - on | 1,3,122 | |
| | | MASTER ALARM pb/lt (3) - push | | All MASTER ALARM lights have reset capability. Pushing any light will reset alarm circuit unless C/W NORM switch in BOOST position. In this case, there is no reset capability with MASTER ALARM light on MDC-1. |
| | | MASTER ALARM pb/lt (3) & tone - out | | |
| CMP | | Applicable C/W lt - remains on | 2 | C/W light remains on until malfunction corrected. |
| | b. | Acknowledge Mode (C/W NORM in ACK) | | |
| ALL | | MASTER ALARM pb/lt (3) & tone - on | 1,3,122 | |
| CDR,LMP | | MASTER ALARM pb/lt (2) - push & hold | 1,3 | MASTER ALARM light on panel 122 does not have acknowledge capability. |
| ALL | | MASTER ALARM pb/lt (3) & tone - out | 1,3,122 | |
| CMP | | Applicable C/W lt - on, for malfunction indication | 2 | |
| CDR,LMP | | MASTER ALARM pb/lt (2) - rel | 1,3 | |
| CMP | | Applicable C/W lt - out | 2 | Light may be recalled by again holding MASTER ALARM light on MDC-1 or MDC-3. |
| | 4.5.5.4 | Master Alarm Tone Headset Control | | |
| | a. | Inhibit Tone | | |
| ALL | | PWR (3) - AUDIO | 9,10,6 | Inhibit function may be selected individually or in any combination. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
|  | b. | Permit Tone |  |  |
| ALL |  | PWR (3) - AUDIO/TONE | 9,10,6 |  |
|  | 4.5.5.5 | Stowable C/W Tone Booster |  | Provided for crew use during sleep cycle and is stowed during Boost and Entry under locker A3. |
|  | a. | Installation |  |  |
| CDR,LMP |  | UTIL PWR - OFF | 15,16 | Removes power from connector on panel 15(16). |
|  |  | Install conn of tone booster |  |  |
|  |  | Place light snsr over MASTER ALARM lt | 1,3 | Velcro attached. |
|  |  | UTIL PWR - on (up) |  |  |
|  |  | Install tone beeper on LH (RH) girth shelf as req |  | Velcro attached. |
|  | b. | Operational Check |  |  |
| CMP |  | C/W LAMP TEST - 1(2) (hold, rel) | 2 | Activates tone beeper as long as switch is held in position 1(2). |

### 4.5.5.6 Normal Operation C/W Master Alarms

The following list denotes those C/W lamps which may illuminate during normal operation. In all cases except SM C/W lights at CM/SM separation, push MASTER ALARM pb/lt to clear MASTER ALARM before proceeding to corrective action.

| C/W Lamp (MDC-2) | Remarks | Corrective Action |
|---|---|---|
| FC BUS DISC | Occurs momentarily when connecting fuel cell to bus. | None |
| SM RCS A, B, C, & D SPS PRESS | Occurs at CM separation from SM because C/W CSM switch at CSM position. | C/W CSM - CM; MASTER ALARM pb/lt - push |
| SM RCS A, B, C, & D | High temperature may illuminate light during (1) boost heating, (2) ΔVs using SM RCS extensively with SIVB attached, or (3) transposition and docking using SM RCS extensively. During phase (1), MASTER ALARM on panel 1 inactive. During phases (2) or (3), normal operating ranges on indicators should be utilized. | None |
| $O_2$ FLOW HI | Occurs (1) during cabin purge, and (2) if urine dump valve left open. May occur during urine dump. | Open cb ECS PRESS XDUCER 2 MNB (MDC-5). |
| CRYO PRESS | Limits may shift under flight conditions and cause low-limit warning during sleep periods. | Reference 4.5.3.7 & 4.5.3.10 |
| FC 1, 2, & 3 | Could occur when an H2 or O2 purge conducted. | None |
| BMAG 1 & 2 | Occurs during power up. | BMAG PWR switch(es) should be left in WARMUP until light extinguished. |

CAUTION AND WARNING SYSTEM

## 4.5.6 TELECOMMUNICATIONS

The T/C system will be in operation throughout entire mission. The information and procedures included here consist of normal and backup procedures that will be utilized to accomplish mission requirements and satisfy test objectives. Some of these procedures will only be required during tests or contingencies.

Most orbital paths will involve passage over several MSFN ground stations within acceptable slant ranges for S-band voice and data communications. Equipment necessary for voice communications, PCM, and TLM transmission will be activated and operating at all times. The UDL will also remain activated and capable of receiving up-data when required.

Action required of crew for voice communications and transmission of real-time PCM TLM will be to ensure optimum radiation and reception of RF signals, either by maintaining SC attitude such that selected antenna is directed toward MSFN station or by changing antennas or antenna attitude with S-band antenna controls. Also, audio control panels (MDC-6, -9, and -10) must be set up in accordance with requirements of individual crewman for control of voice transmission and reception.

The reception of up-data for updating the CTE and receiving real-time commands (RTCs) will require no action on part of crew since the UDL will normally remain activated and will utilize the same antenna as that used for S-band voice and data operations. For updating command module computer, however, up-telemetry switches (panels 2 and 122) must be set to ACPT position.

The following procedures are presented with the assumption that appropriate electrical buses are powered and that proper circuit breakers are closed.

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.5.6.1 | Basic Switch Configuration | | |
| LMP | 1 | Apply A-C pwr<br>TELCOM GRP 1 - AC1<br>TELCOM GRP 2 - AC2 | 4 | |
| ALL | 2 | Audio pnl (3)<br>MODE (3) - INTERCOM/PTT<br>S BD (3) - T/R<br>SUIT PWR (3) - on (up)<br>AUDIO CONT (3) - NORM<br>PWR (3) - AUDIO/TONE<br>VHF AM (3) - T/R<br>INTERCOM (3) - T/R<br>PAD COMM (3) - OFF | 9,10,6 | Each crewman's individual audio panel must be activated to enable him to receive or transmit voice signals. T/R position enables voice transmission and reception over selected audio channel. RCV position permits reception only. |
| CDR | | VHF RNG - NORM | 9 | |
| LMP | 3 | S band norm | 3 | |
| | | S BD XPNDR - PRIM | | Whenever S BD XPNDR switch positioned from PRIM to SEC or from SEC to PRIM, hesitate momentarily in OFF position to allow relay actuation to follow switch action. S-band phaselock will be lost upon switching to alternate transponder. Phaselock must be re-established. |
| | | S BD PWR AMPL PRIM - PRIM<br>S BD PWR AMPL HI - HI<br>S BD MODE VOICE - VOICE<br>S BD MODE PCM - PCM<br>S BD MODE RNG - RNG | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4 | S band aux | | |
| LMP | | S BD AUX TAPE - off (ctr) | 3 | |
| | | S BD AUX TV - off (ctr) | | |
| | 5 | Up TLM | | |
| | | UP TLM DATA - DATA | | |
| | | UP TLM CMD - NORM | | |
| | | PWR AMPL tb - gray | | Gray indicates power applied to S-band power amplifier. |
| | | TAPE MOTION tb - gray | | Gray indicates tape in motion. |
| | 6 | S band ant | | |
| | | S BD ANT OMNI A - A | | If OMNI D is selected by crewman, ground switching capability will be lost. Since MSFN has the capability only to command OMNI D or to reset, manual selection of OMNI D essentially disables antenna command capability. |
| | | S BD ANT OMNI - OMNI | | |
| | 7 | VHF AM | | |
| | | VHF AM A - SIMPLEX | | |
| | | VHF AM B - off (ctr) | | |
| | | VHF AM RCV - off (ctr) | | |
| | | VHF AM SQLCH tw (2) - noise + 1 | | In the event marginal VHF voice communications is experienced and VHF voice communications is required, VHF receiver squelch may be disabled by setting the appropriate thumbwheel to 1. This will allow weak-signal reception, but will severely degrade DSE recorded voice. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| LMP | 8 | VHF BCN - OFF<br>VHF RNG - OFF | 3 | |
| | 9 | Tape rcdr<br>TAPE RCDR PCM - PCM/ANLG<br>TAPE RCDR RCD - RCD<br>TAPE RCDR FWD - FWD | | |
| | 10 | Pwr<br>SCE PWR - NORM<br>PMP PWR - NORM | | |
| | 11 | TLM inputs<br>PCM BIT RATE - LO | | |
| | 12 | VHF ANT - SM LEFT | | |
| CMP | 13 | RNDZ XPNDR PWR - OFF | 100 | |
| | 14 | RNDZ XPNDR TEST - OPR | 101 | |
| LMP | 15 | S BD SQLCH - ENBL | 3 | |
| | 4.5.6.2 | High Gain Antenna Operation | | |
| CMP | | cb HI GAIN ANT (2) - close | 225 | |
| | | HI GAIN ANT TRACK - MAN | 2 | |
| | | HI GAIN ANT SERVO - PRIM | | |
| | | HI GAIN ANT BEAM - WIDE | | |
| | | HI GAIN ANT PWR - on (up) | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | Determine req ant coordinates<br>If IMU aligned, 4.8.1.16<br>If G&N not available, trial & error method must be used | | |
| | | Verify that req coordinates are within full coverage region | | Refer to CSM DATA BOOK, section 4.7, HGA Scan and Warning Limit, Yaw-Pitch Coordinates. Reliable acquisition can be accomplished with YAW-PITCH coordinates in full coverage region. In the CSM skin interference zone, RF reflections will cause no problems when operating in MANUAL, AUTO or REACQ mode, when in WIDE BEAM. After acquisition, the antenna will track through CSM skin interference zone and scan limit zone while in NARROW beam and in either AUTO or REACQ modes without incurring an interference problem.<br>Should acquisition be attempted in the CSM skin interference zone in either NARROW or MEDIUM beam while in AUTO or REACQ mode, acquisition problems may be encountered. MSFN and SC will experience (a) low signal strength indicating lockup on a side lobe or (b) varying signal strength caused by antenna alternately switching between wide and narrow beamwidth. SC antenna pitch and yaw indicator will also provide visual indication of condition (b). Other indicators of the interference condition include noise or loss of voice or track loss.<br>Upon detection of this situation, attempt one of the following.<br>a. Change CSM attitude to provide antenna coordinates in the full coverage region. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | | | b. Allow up to 60 seconds for the expected CSM attitude variation to alleviate the condition.<br>c. In attitude hold condition, operate in wide beam mode.<br>d. Transfer to narrow beam and acquire earth manually. |
| CMP | HI GAIN ANT PITCH & YAW cont (2) - set in req coordinates | 2 | |
| | If in earth orb | | |
| LMP | S BD PWR AMPL HI - off (ctr) | 3 | |
| | S BD ANT OMNI - HI GAIN | | |
| CMP | S BD ANT ind - >1/2 scale | 2 | |
| | HI GAIN ANT TRACK - AUTO or REACQ | | With TRACK switch in REACQ, antenna will reposition to position control settings when the antenna reaches the scan limit. To prevent acquisition problems, predicted earth-rise should be set in the full coverage region. |
| | HI GAIN ANT BEAM - as desired | | |
| | S BD ANT ind - >1/2 scale | | |
| | When omni ant oper is desired | | |
| | HI GAIN ANT TRACK - MAN | | |
| | HI GAIN ANT PITCH cont - -52° | | |
| | HI GAIN ANT YAW cont - 270° | | |

4.5.6.3 S-Band Xponder Modes

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | Voice, RT-HBR Data, Ranging | | |
| LMP | Sel BASIC except | | |
| | PCM BIT RATE - HI | 3 | |
| | Voice, RT-LBR Data, Ranging | | |
| | Sel BASIC | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | Voice, RT-HBR Data | | |
| | Sel BASIC except | | |
| LMP | S BD MODE RNG - OFF | 3 | |
| | PCM BIT RATE - HI | | |
| | Voice, RT-LBR Data | | |
| | Sel BASIC except | | |
| | S BD MODE RNG - OFF | | |
| | Voice & Ranging | | |
| | Sel BASIC except | | |
| | S BD MODE PCM - ctr | | |
| | Voice | | |
| | Sel BASIC except | | |
| | S BD MODE PCM - ctr | | |
| | S BD MODE RNG - OFF | | |
| | Voice & LBR PCM with Apollo/Recovery Instrumented Aircraft (A/RIA) | | |
| | Sel BASIC except | | |
| | S BD MODE RNG - OFF | | |
| 4.5.6.4 | FM Xmtr Modes | | |
| | Dump PCM/Analog | | |
| | Sel BASIC except | | |
| | TAPE RCDR FWD - REWIND | | |
| | S BD AUX TAPE - TAPE | | |
| | TAPE RCDR RCD - PLAY | | |
| | TAPE RCDR FWD - FWD (after rewind complete) | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | TAPE MOTION tb - gray<br>Rewind & return to BASIC | 3 | Gray indicates tape in motion. |
| | Dump LM PCM<br>Sel BASIC except<br>TAPE RCDR FWD - REWIND<br>S BD AUX TAPE - TAPE<br>TAPE RCDR PCM - LM PCM<br>TAPE RCDR RCD - PLAY<br>TAPE RCDR FWD - FWD (after rewind complete) | | |
| | TAPE MOTION tb - gray<br>Rewind & return to BASIC | | Gray indicates tape in motion. |
| | TV Camr Oper (black & white)<br>WARNING<br>Ensure that S BD AUX TV sw is off (ctr) prior to conn or disconnecting TV camr. | | |
| | Unstow camr, opt sight, lens, light atten, & cables<br>S BD AUX TAPE - ctr, or DN VOICE BU | | Positioning S BD AUX TAPE - TAPE, disables TV function. |
| | S BD AUX TV - off (ctr)<br>Conn pwr & RF cables | | |
| | Install proper lens<br>(telephoto out of focus at <143 ft)<br>(wide angle out of focus at <18 in.)<br>Attach light atten to camr lens<br>(atten clamps around barrel) | | Camera is stowed with wide angle lens attached. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP | Install opt ring sight in top or side mount as desired | | |
| | S BD AUX TV - TV | 3 | There will be a 90-second delay for PA warmup before FM transmission commences. |
| | ALC (camr) - IN (norm), OUT (when detail on dim objects in presence of of bright objects is desired) | Camr | |
| | Pwr (camr) - ON | | |
| | Adj light atten as req (lower numbers have less atten) | | |
| | When TV oper is completed | | |
| | Pwr (camr) - OFF | | |
| | S BD AUX TV - off (ctr) | | |
| | Disassemble & stow equip as desired | | |
| | TV Camr Oper (color) | | |
| CMP | Unstow TV camr, mon, & cables | | |
| | Install camr & mon in mounts | | |
| | Mon pwr sw - OFF | | |
| | Camr xmit/stby sw - STANDBY (down) | | Camera will transmit sync but no video to MSFN in this configuration. |
| | Camr auto light cont sw - AVG | | |
| | Adj camr | | |
| | Focus - 4 ft | | |
| | Zoom - 25mm | | |
| | Aperture - f/44 | | |
| | Conn camr-to-mon cable (arrow-to-arrow) | | |
| LMP | S BD AUX TAPE - ctr, or DN VOICE BU | 3 | |
| | S BD AUX TV - ctr | | |
| | Conn camr pwr & RF cable | | |
| | S BD AUX TV - TV | | Power amplifier warmup time is 90 seconds. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | Mon pwr sw - on (up) | Camr | |
| | Adj mon cont for best image | | |
| | (VER, HOR, BRT & CONT cont knobs) | | |
| | Adj cab lighting to max | | |
| ALL | FLOOD LTS - OFF (CCW) | 5,8,100 | |
| | FLOOD DIM - 1 | | |
| | FLOOD FIXED - OFF | | |
| | FLOOD LTS - full BRT (CW) | | |
| CMP | Using mon, adj camr cont | Camr | |
| | Lens aperture | | |
| | Zoom cont | | |
| | Focus cont | | |
| | To xmit to MSFN | | |
| | Camr xmit/stby sw - XMITT (up) | | Transmission will begin immediately if power amplifier warmup time has been satisfied. |
| | When TV oper is complete | | |
| LMP | S BD AUX TV - ctr | 3 | |
| CMP | Disassemble & stow camr, mon, & cables | | |
| ALL | Adj cab lighting as desired, 4.5.8 | | |
| | 4.5.6.5 VHF/AM Modes | | BASIC switch configuration provides CSM-MSFN voice, CSM-LM voice, and CM-recovery voice. |
| | Simplex A | | |
| | Select BASIC | | |
| | Duplex A | | PLSS operation. Should not be used until after CSM/SIVB separation as MSFN transmission on VHF AM B will interfere with booster TM. |
| LMP | Sel BASIC except | | |
| | VHF AM A - DUPLEX | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | Simplex B | | CM-recovery backup voice. Should not be used until after CSM/SIVB separation as MSFN transmission on VHF AM B will interfere with booster TM. |
| LMP | Sel BASIC except | | |
| | VHF AM B - SIMPLEX | 3 | |
| | VHF AM A - off (ctr) | | |
| | Duplex B | | PLSS backup operation. |
| | Sel BASIC except | | |
| | VHF AM B - DUPLEX | | |
| | VHF AM A - off (ctr) | | |
| | RCV ONLY A | | Provides capability to monitor recovery VHF voice transmissions. |
| | Sel BASIC except | | |
| | VHF AM RCV - A | | |
| | VHF AM A - off (ctr) | | |
| | 4.5.6.6 VHF AM Ranging Mode | | Activation of VHF ranging significantly reduces voice capability. In the event marginal VHF voice communications is experienced and voice communications is required, both CSM and LM VHF ranging equipment (DRG and RTTA) may be turned off during the communication period to provide increase voice margin. |
| | VHF AM A - off (ctr) | | |
| | VHF AM B - DUPLEX | | |
| | VHF RNG - on (up) | | |
| | If P20 operating & VHF AM ranging option selected | | |
| CMP | TRACKER lt - on | 2,140 | The CMC will activate TRACKER light and wait for a "data good" signal from digital ranging generator. |
| CDR | EMS FUNC - VHF RNG | 1 | |
| | EMS MODE - VHF RNG | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | CAUTION<br>There must be no VHF AM voice transmission by LM, CSM or MSFN for ≈12 sec after VHF RNG - RSET. | 9 | Voice transmission at this time could interfere with accuracy of ranging signal. |
| CDR | VHF RNG - RSET (1 sec min)<br>RNG ind - B00000 | 1 | Momentary up, hold for 1 second minimum. When VHF RNG switch is placed to RSET, RNG indicator will reset to zero, and operator will hear mid tone (3.95 kHz) and then low tone (2.47 kHz). |
| | If P20 operating & VHF AM ranging option selected | | |
| CMP | TRACKER lt - out | 2,140 | TRACKER light - out (no OCDU failure) and RNG indicator starts counting up ≈4 seconds after termination of low tone. RNG indicator is interpreted as range in nautical miles to nearest .XXNM. |
| CDR | RNG ind - BXXXXX | 1 | |
| | 4.5.6.7 DSE Record Modes | | Under nominal conditions MSFN will control tape recorder operation. |
| | Record HBR CM Data, CM/IC, LM/IC, LM/PCM<br>Sel BASIC except | | In order to dump LM PCM when recorded with CM PCM, two dumps are required. |
| LMP | PCM BIT RATE - HI<br>VHF AM RCV - B DATA | 3 | |
| | Record LBR CM Data, CM/IC, LM/PCM, EVA/LM/IC<br>Sel BASIC except<br>VHF AM RCV - B DATA | | In order to dump LM PCM when recorded with CM PCM, two dumps are required. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | Record HBR CM Data, EVA/LM/IC, CM/IC | | |
| LMP | Sel BASIC except | | |
| | VHF AM A or B - DUPLEX | 3 | |
| | PCM BIT RATE - HI | | |
| | | | |
| | Record LBR CM Data, EVA/LM/IC, CM/IC | | |
| | Sel BASIC except | | |
| | VHF AM A or B - DUPLEX | | |
| | | | |
| | 4.5.6.8 Relay Mode (LM Voice to MSFN) | | |
| | | | |
| | Voice Relay (With VHF Ranging) | | |
| | Sel BASIC except | | |
| CMP | MODE - VOX | 10 | |
| | VOX SENS tw - 5 | | |
| | S BD - OFF | | |
| | INTERCOM - OFF | | |
| | AUDIO CONT - BU | | |
| CDR | MODE - VOX | 9 | When operating in VOX mode, LM reply should be delayed 2 seconds to allow for VOX release time. |
| | VOX SENS tw - as req | | |
| LMP | S BD MODE VOICE - RELAY | 3 | |
| | VHF AM A - off (ctr) | | |
| | VHF AM B - DUPLEX | | |
| | VHF RNG - on (up) | | |
| | | | |
| | Voice Relay (with LM LBR PCM record) | | |
| | Sel BASIC except | | |
| CMP | MODE - VOX | 10 | |
| | VOX SENS tw - 5 | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | S BD - OFF | 10 | |
| | INTERCOM - OFF | | |
| | AUDIO CONT - BU | | |
| CDR | MODE - VOX | 9 | When operating in VOX mode, LM reply should be delayed 2 seconds to allow for VOX release time. |
| | VOX SENS tw - as req | | |
| LMP | S BD MODE VOICE - RELAY | 3 | |
| | VHF AM RCV - B DATA | | |
| 4.5.6.9 | Rendezvous Transponder Activation and Self Test | | |
| | RNDZ XPNDR PWR - HTR for 24 min, then on (up) | 100 | One minute warmup is required if self-test only is to be performed. |
| | SYS TEST (LH) - XPNDR | 101 | |
| | SYS TEST (RH) - A (RRT XMTR OUT PWR) | | |
| | SYS TEST ind - >1.0 vdc | | |
| | SYS TEST (RH) - B (RRT AGC SIG) | | |
| | RNDZ XPNDR TEST - on (up) | | On (up) position is momentary. |
| | SYS TEST ind - >1.0 vdc (self-test) | | |
| | RNDZ XPNDR TEST - OPR | | |
| | SYS TEST ind - 0-4.5 vdc (opr) | | Indicates relative received signal strength, (preferred position during rendezvous). |
| | SYS TEST (RH) - C (RRT FREQ LOCK) | | |
| | SYS TEST ind | | |
| | Unlocked - <0.8 vdc | | |
| | Locked - >4.0 vdc | | RF lockup indicated by 4.0 vdc in OPR with LM interrogation. |
| | SYS TEST (RH) - B (RRT AGC SIG opr) | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.5.6.10 Backup Modes | | |
| | Up Voice Backup | | Requires coordination with MSFN. Updata signal (noise) will be present in headsets until MSFN reconfigures for this mode. |
| LMP | Sel BASIC except | | |
| | UP TLM DATA - UP VOICE BU | 3 | |
| | Down Voice Backup | | |
| | Sel BASIC except | | |
| | S BD MODE PCM - ctr | | |
| | S BD AUX TAPE - DN VOICE BU | | |
| | S BD MODE RNG - OFF | | |
| | PCM BIT RATE - HI | | |
| | Down Voice & LBR RT Data Backup | | |
| | Sel BASIC except | | |
| | S BD AUX TAPE - DN VOICE BU | | |
| | S BD MODE RNG - OFF | | |
| | Key | | |
| | Sel BASIC except | | |
| | S BD MODE PCM - KEY | | |
| | S BD MODE RNG - OFF | | |
| | Down Data Backup | | |
| | Sel BASIC except | | |
| | PMP PWR - AUX | | |
| | 4.5.6.11 Pad Communications | | |
| | Sel BASIC except | | |
| | TAPE RCDR FWD - off (ctr) | | |
| | Prior to launch | | |
| ALL | PAD COMM (3) - T/R (or RCV) | 9,10,6 | PAD COMM switch can be used after launch for intercom backup with PAD COMM VOL thumbwheel decreased. |
| | PAD COMM VOL tw (3) - as desired | | |
| | Launch -10:00 | | |
| | PAD COMM (3) - OFF | | |

### 4.5.7 MECHANICAL SYSTEMS

Procedures for opening and closing side and forward hatches are presented in the following paragraphs, as well as procedure for operation of side hatch counterbalance mechanism. The procedures include operational performance from the interior and exterior of the CM.

#### 4.5.7.1 Opening Side Hatch for EVT

a. Opening Side Hatch From CM Interior Without Utilizing Counterbalance Mechanism

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| ALL | PGAs donned & checked, 4.5.4.9 | | |
| LMP | Procure tether & tool B & fasten to arm | | Tool B stowed in volume A1. |
| CMP | Dump CM press, 4.5.4.11 | | |

**WARNING**

Counterbalance piston chamber must be vented prior to opening hatch in zero G.

Deactivate counterbalance mechanism, 4.5.7.3, step a

**CAUTION**

To prevent shearing lock pin, set lock pin rel knob to UNLOCK prior to operating actr handle.

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | Lock pin rel knob - UNLOCK [check that red shear pin is extd ≈0.5 inch (rh couch) &/or white ind is opposite yellow mark (ctr/lh couch)] | Side hatch | Pin can be sheared if left in LOCK position. |
| | Gear box sel - UNLATCH | | |
| | Actr handle sel - U (unlatch) | | |
| | Actr handle rel - push or squeeze | | Push (button) or squeeze (bar) releases actuator handle for operation. |
| | Actr handle - opr (until hatch can be opened) | | |
| | **CAUTION** | | |
| | If hatch does not open normally & there are no crewmen EVA, do not proceed with attempt to open hatch. | | |
| | If unable to open hatch & crewmen are EVA | | |
| | Recheck position of conts | | |
| | Ensure no foreign objects caught in hatch assy (latches, latch linkage, gear box linkage or hinges) | | |
| | Actr handle - opr (incr load) | | |
| | If still unable to open hatch | | |
| | Remove clevis pins (4 places) with tool B | | |
| | Move latches to unlatch position with tool F | | Wrench flats are on each latch assembly. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | Actr handle sel - L<br>Stow actr handle<br>Gear box sel - LATCH | Side hatch | |
| | b. Open Side Hatch From CM Interior Using Counterbalance Mechanism | | |
| ALL | PGAs donned & checked, 4.5.4.9 | | |
| CMP | Dump CM press, 4.5.4.11<br>Vent piston chamber<br>GN2 vlv handle - pull (inbd)<br>GN2 press ind - min | | |
| | CAUTION<br>To prevent shearing lock pin, set lock pin rel knob to UNLOCK prior to operating actr handle. | | |
| | Lock pin rel knob - UNLOCK [check that red shear pin extd ≈0.5 inch (rh couch) &/or white ind opposite yellow mark (ctr/lh couch)] | | Pin can be sheared if left in LOCK position. |
| | Gear box sel - UNLATCH<br>Actr handle sel - U (unlatch) | | |
| | Actr handle rel - push or squeeze<br>Actr handle - opr (until hatch latches are unlatched) | | Push (button) or squeeze (bar) releases actuator handle for operation. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | CAUTION | | |
| | If latches do not open normally, do not proceed with attempt to open hatch. | | |
| CMP | If unable to open latches & return trnfr cannot be performed through CM/LM tunl | Side hatch | |
| | Recheck position of conts | | |
| | Vent piston chamber | | |
| | GN2 vlv handle - pull (inbd) | | |
| | GN2 press ind - min | | |
| | Insure no foreign objects caught in hatch assy (latches, latch linkage, gear box linkage) | | |
| | Actr handle - opr (incr load) | | |
| | If still unable to open hatch | | |
| | Remove clevis pins (4 places with tool B | | |
| | Move latches to unlatch position with tool F | | Wrench flats are on each latch assembly. |
| | Actr handle sel - L | | |
| | Stow actr handle | | |
| | Gear box sel - LATCH | | Prepares hatch for closing. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | CAUTION<br>Do not puncture second press bottle to open hatch. This press bottle is in reserve for postlanding. | | |
| CMP | Pressurize piston chamber<br>GN2 vlv handle - push slowly until hatch is open & locked | Side hatch | |
| | If unable to open hatch<br>Insure no foreign objects caught in hatch hinges or counterbalance mechanism | | |
| | CAUTION<br>Do not disconnect hatch bellcrank with hatch in open position. | | |
| | Depressurize piston chamber<br>GN2 vlv handle - pull inbd until GN2 press ind - min | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| CMP | If piston chamber will not vent<br>Disengage counterbalance<br>Tool B - insert into counterbalance locking pin | Side hatch | |
| | Rot tool B (CCW) to stop (4-1/2 turns) | | Disengages piston bellcrank. Tool F may also be used. Counterbalance assist of hatch opening will not be available for postlanding. |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | c. Opening Side Hatch From CM Exterior<br>PGAs donned & checked, 4.5.4.9<br>Dump CM press | | |
| | CAB PRESS DUMP vlv - insert tool B, depress & rot (CW) to stop | | Depressing pressure equalization valve with tool B will release inside actuating handle from stowed position, and rotating to stop will open valve. |
| | WARNING<br>Counterbalance piston chamber must be vented prior to opening hatch in zero G. | | |
| | Deactivate counterbalance mechanism, 4.5.7.3, step a<br>Wait 70 sec min, then insert tool B in hatch actuation socket | | |
| | Rot CCW (368°) until hatch can be opened | | Releases hatch latches. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.5.7.2 Closing Side Hatch for EVT | | |
| | a. Closing Side Hatch From CM Interior | | |
| CMP | Check EVT equip clear of hatch & hatch frame | Side hatch | |
| | Actr handle sel - L (latch) | | |
| | Gear box sel - LATCH | | |
| | Open door rel handle - pull | | D-ring. |
| | Verify latches are in open position | | |
| | Close hatch | | |
| | Open door rel handle - stow | | |
| | Actr handle rel - push or squeeze | | |
| | Actr handle - opr (while holding hatch closed) | | |
| | Verify hatch fully latched | | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | If hatch does not latch | | |
| | Recheck position of conts | | |
| | Check latches for unlatch position | | |
| | Insure hatch is closed sufficiently for latches to engage | | |
| | Insure no foreign objects caught in hatch assy | | |
| | Actr handle - opr (incr load) | | |
| | If hatch still does not latch | | |
| | Install jackscrews (3) to restrain hatch in closed position | | |
| | Disconnect gearbox from linkage | | Left bank of latches (looking outboard) cannot be closed if gearbox fails in extreme open position but can be closed if actuator handle can be operated for one complete stroke towards closure. |
| | Remove clevis pins (4 places) with tool B | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | Move latches to latch position with tool F<br>Install (2) clevis pins in threaded holes in linkage bell cranks of upper gearbox side & lower hinge side (clevis pins installed when ≈ half the threads are visible) | Side hatch | Wrench flats are on each latch assembly. |
| | If hatch still will not latch, tighten jackscrews (3) to close hatch | | Four latches have kickers to force latch open during unlatch cycle. If one is jammed open, jackscrews will not close hatch to pressure seal and there will be ≈0.6 inch between hatch and seal. Latch must be unjammed or removed (using torque set screwdriver) to close hatch completely. |
| | x x<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | Lock pin rel knob - LOCK (auto)<br>LOCK PIN ind - not extd (rh couch) and/or that white ind is opposite white mark (ctr/lh couch) | | Verifies lock pin has automatically engaged.<br>Indicates lock pin is engaged. |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>x x | | |
| | If hatch was opened from CM exterior & lock pin rel knob does not lock, LOCK PIN rset - RSET (push) | | |
| | x x<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | Actr handle - stowed position<br>Actr handle sel - N (neut)<br>Repressurize CM, 4.5.4.8 | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | b. Closing Side Hatch From CM Exterior | | |
| CMP | Check EVT equip clear of hatch & hatch frame | Side hatch | |
| | Actr handle sel - N (neut) | | |
| | Gear box sel - N (neut) | | |
| | Open door rel handle - pull | | D-ring. |
| LMP | Close hatch | | |
| CMP | Open door rel handle - stow | | |
| LMP | Hatch actuation socket - insert tool B | | |
| | Rot CW (382°) to stop | | Engages hatch latches. |
| | Tool B - remove from socket | | |
| CMP | LOCK PIN rset - RSET (push) | | Engages lock pin. Mechanism will automatically return 14° (CCW) when tool B is removed. |
| | If mechanism does not auto return 14° (CCW) when tool B is removed, reinsert tool B & man rot 14° (CCW) | | |
| | Lock pin rel knob - LOCK | | |
| | LOCK PIN ind - not extd (rh couch) and/or white ind opposite white mark (ctr/lh couch) | | |
| LMP | If PRESS EQUAL VLV is open | | |
| | PRESS EQUAL VLV - insert tool B & rot (CCW) to stop | | Seals CM pressure equalization valve. |
| | Remove tool B | | |
| | Repressurize CM, 4.5.4.8 | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.5.7.3 Side Hatch Counterbalance Operation | | |
| | a. Deactivate Counterbalance Mechanism | | |
| CMP | 1. Vent piston chamber | Side hatch | |
| | GN2 vlv handle - pull (inbd) | | Squeeze handle to unlock. |
| | GN2 press ind - min | | |
| | 2. Disengage counterbalance (crew option) | | Use either the pip pin or counterbalance locking pin to disengage counterbalance. Do not use both methods. |
| | (A) Counterbalance locking pin<br>Tool B - insert into counterbalance locking pin | | |
| | Rot tool B (CCW) to stop (4-1/2 turns) | | Disengages piston bellcrank from hatch bellcrank. Tool F may also be used. |
| | or (B) Pip pin on counterbalance arm<br>Pull pip pin connecting roller track fitting & bell crank | | |
| | Stow pip pin | R-10 | |
| | Push roller track fitting to end of track & check if roller will come off - stow roller(s) that can be removed | | |
| | b. Activate Counterbalance Mechanism | | |
| | 1. Engage counterbalance (if disengaged) | | Engage counterbalance by method used to disengage counterbalance: pip pin or counterbalance locking pin. |
| | (A) Counterbalance locking pin<br>Tool B - insert into counterbalance locking pin | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | CAUTION<br>Do not continue torquing after locking nut has bottomed or roll pin may shear causing locking pin cap to become a loose part. | | |
| CMP | | Rot tool B (CW) to stop (4-1/2 turns) | Side hatch | When installing counterbalance locking pin, verify that locking pin is aligned with hole in crank. After seating roll pin, do not apply any additional torque. Excessive torque will shear roll pin and cause locking pin cap to become a loose part. If this should happen, stow loose cap. This is not detrimental to operation of system. Once locking pin is engaged and cap has separated, counterbalance disconnect may be accomplished by pulling pip-pin or removing locking pin using tool F. |
| | or (B) | Pip-pin on counterbalance arm<br>Remove roller(s) from stowage (if removed) & re-install on track fitting<br>Remove pip-pin from stowage<br>Conn counterbalance to track fitting with pip-pin | | |
| | 2. | Pressurize piston chamber<br>GN2 vlv handle - push (outbd) | | Squeeze handle to unlock. |
| LMP | | GN2 press ind - green | | GN2 pressure indicator will display charge bottle pressure when GN2 valve handle in charge position (outboard). To provide maximum assist, GN2 valve handle will be left in charge position through time counterbalance activated. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| LMP | If GN2 press ind - below green<br>GN2 ratchet handle - opr | Side hatch | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | 4.5.7.4 Opening Fwd Hatch | | |
| | a. Opening Fwd Hatch From CM Interior | | |
| | Equalize CM/LM press, 4.5.4.14 | | If required. Tunnel pressure integrity check is incorporated into these procedures. |
| | Actr handle rel - PULL & ROTATE | Tunl | To free actuator handle for operation, release is rotated to stop. |
| | Actr handle - pull to stop | | Actuator handle should move ≈80°. |
| | Actr handle sel - U (unlatch) | | |
| | Actr handle - push to stop | | Actuator handle should move ≈60° to release latches. |
| | Gearbox disconnect socket - U (verify) | | |
| | Actr handle sel - STOW | | |
| | Actr handle - push to stowed position | | Actuator handle release automatically locks handle in stowed position. |
| | Remove & stow fwd hatch | | Hatch should be stowed in LHEB. |
| | b. Opening Fwd Hatch From CM Exterior | | |
| ALL | PGAs donned & checked, 4.5.4.9 | | |
| CDR | PRESS EQUAL vlv - OPEN<br>Tool B - insert, hold depressed & rot (CW) | Fwd hatch | |
| CMP | TUNL VENT vlv - LM/CM ΔP | 12 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | LM/CM ΔP ind - 0.0 psid | 12 | Report indication to CDR. Accuracy of gauge is ±0.1 psi at -1.0 to +1.0 psid and 70°F, ±0.2 psi at +1.0 to +4.0 psid and 70°F. |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>If CMP is unable to mon LM/CM ΔP ind when PRESS EQUAL vlv is positioned to OPEN, wait min of 60 sec before attempting to opr hatch actuation socket<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | LM pressure is normally 0.2 psia below that of CM. |
| CDR | Hatch actuation socket - insert tool B & rot (CCW)<br>Remove & stow fwd hatch in LHEB | Tunl | Disconnects gear box and releases hatch latches. |
| | 4.5.7.5 Closing Fwd Hatch | | |
| LMP or CMP | Closing Fwd Hatch From CM Interior | | Performed by LMP or CMP. |
| | Obtain fwd hatch from stowage | Fwd hatch | Forward hatch stowed in LHEB. |
| | Position hatch against sealing surface | | Align equivalent colored arrows. |
| | Actr handle rel - PULL & ROTATE | | To free actuator handle for operation, release rotated to stop. |
| | Actr handle - pull to stop | | Actuator handle should move ≈80°. |
| | Actr handle sel - L (latch) | | |
| | Actr handle - push to stop | | Actuator handle should move ≈60° to engage latches. |
| | Verify gearbox disconnect socket is opposite L mark on hatch | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP<br>or<br>CMP | Actr handle sel - STOW<br>Actr handle - push to stowed position | Fwd hatch | Actuator handle release automatically locks handle in stowed position. |
| | Push man gearbox lock (chrome tab) | | Verifies that gear box lock is engaged. |
| CDR | PRESS EQUAL vlv - CLOSE (CW) | | Yellow indicator pin must be in green zone and valve handle must be in yellow-band area (indicates valve is fully closed). |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>Cannot close PRESS EQUAL vlv<br>Remove fwd hatch, 4.5.7.4<br>Insert Tool B in external tool interface for additional leverage, hold depressed & rot (CCW)<br>Install fwd hatch<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | Repressurize CM, 4.5.4.8 | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.5.8 FLOODLIGHT OPERATING MODES | | |
| | 4.5.8.1 Prim Floodlight Mode | | |
| ALL | FLOOD LTS - OFF (CCW)<br>FLOOD DIM - 1<br>FLOOD LTS - full dim or full BRT | 5,8,100 | |
| | 4.5.8.2 Sec Floodlight Mode | | Operation in secondary mode is a backup only to be used in the event of DIM-1 circuitry in-flight failure. The DIM-2, dimmed floodlight predicted operating life is ≈100 hours. |
| | FLOOD LTS - OFF (CCW)<br>FLOOD DIM - 2<br>FLOOD LTS - full BRT (CW) | | |

FLOODLIGHT OPERATING MODES

## 4.6 G&C REFERENCE DATA

This section provides data which generally apply to all G&C procedures in sections 4.7 through 4.16 and 5.1 through 5.3. The data do not include procedures but contains information which may be referenced in various procedures, may contain application of procedures, or may be helpful in applying the procedures.

### 4.6.1 G&C OPERATING NOTES

G&C operating notes are separated into three categories: G&C operations, SCS operations, and G&N operations. Notes for G&C operations provide data associated with guidance and control functions in general while notes for SCS and G&N operations are more specific to their systems.

### 4.6.1.1 G&C Operations

1. ULLAGE: For ullage switch setup with or without attitude control, see figure 4.6-1. Normally, the setup should include attitude control.

2. RCS JET, VENT, RADIATOR, AND ANTENNA LOCATIONS: SM and CM RCS jets, vent, and radiator locations are illustrated in figure 4.6-2.

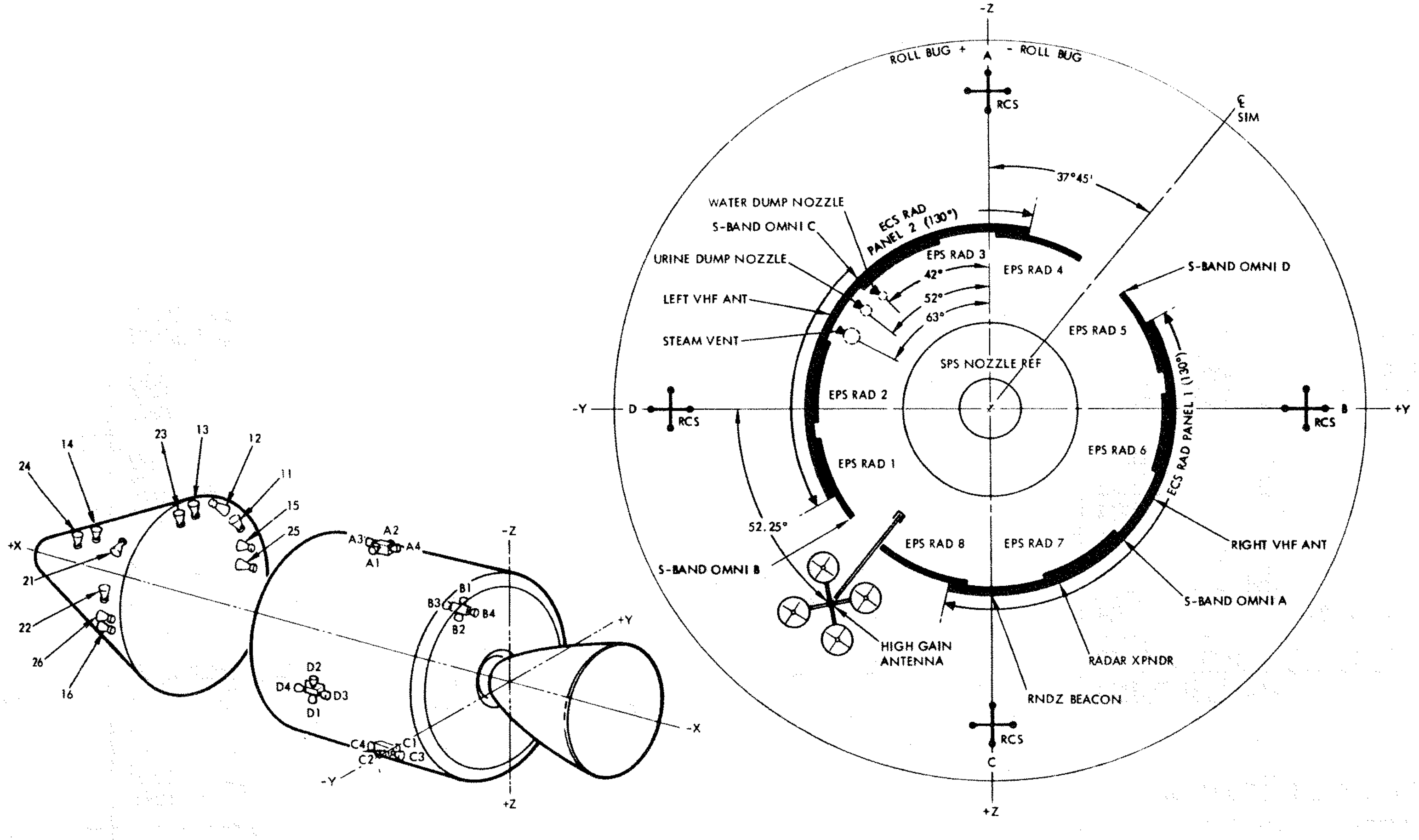
3. SCS LOGIC BUS POWER DISTRIBUTION: SCS logic bus circuit breakers on panel 8 provide MNA and MNB power to four SCS logic buses. Figure 4.6-3 delineates power source and power distribution for SCS controls (pushbuttons, functions, and switches).

   Main bus power to SCS logic buses 1 and 4 is controlled only by the SCS logic bus circuit breakers on panel 8. Power to SCS logic buses 2 and 3 is controlled by SCS logic bus circuit breakers on panel 8 and the LOGIC 2/3 PWR switch on panel 7. Other than SCS TVC, equipment loads can only be removed from a specific logic bus by selecting acceptable control positions not powered by that bus. (See figure 4.6-3.)

| Type of Ullage Desired | | Required AUTO RCS Switch Positions (Jets Firing*) | | | | | | | | RCS Jets* Providing Attitude Hold Capability | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pitch | | | | Yaw | | | | | |
| | | A3 | C3 | A4 | C4 | B3 | D3 | B4 | D4 | Pitch | Yaw |
| 2 Jet-Quad A/C Pitch Jets C3 and A4 | Without Attitude Control | OFF | MNA or MNB | MNA or MNB | OFF | MNA or MNB | OFF | OFF | MNA or MNB | None | B3 and D4 |
| | With Attitude Control | MNA or MNB | MNA or MNB | MNA or MNB | MNA or MNB | MNA or MNB | OFF | OFF | MNA or MNB | A3 and C4 | B3 and D4 |
| 2 Jet - Quad B/D Yaw Jets D3 and B4 | Without Attitude Control | MNA or MNB | OFF | OFF | MNA or MNB | OFF | MNA or MNB | MNA or MNB | OFF | A3 and C4 | None |
| | With Attitude Control | MNA or MNB | OFF | OFF | MNA or MNB | MNA or MNB | MNA or MNB | MNA or MNB | MNA or MNB | A3 and C4 | B3 and D4 |
| 4 Jet - Quad ABCD Jets A4, B4, C3, D3 | Without Attitude Control | OFF | MNA or MNB | MNA or MNB | OFF | OFF | MNA or MNB | MNA or MNB | OFF | None | None |
| | With Attitude Control | MNA or MNB | MNA or MNB | MNA or MNB | MNA or MNB | MNA or MNB | MNA or MNB | MNA or MNB | MNA or MNB | A3 and C4 | B3 and D4 |

*See figure 4.6-2 for explanation of jet code.

Figure 4.6-1. SCS Ullage Setup



CM RCS CODE

FIRST DIGIT: SYSTEM (1 OR 2)
SECOND DIGIT: 1, 2 (+, -ROLL) 3, 4 (+, -PITCH) 5, 6 (+, -YAW)

SM RCS CODE

1 AND 2 ARE ROLL JETS
3 AND 4 ARE A/C PITCH OR B/D YAW JETS
1 AND 3 = + ROTATION, 2 AND 4 = - ROTATION

SM-2A-2212

Figure 4.6-2. RCS Jet, Vent, Radiator, and Antenna Locations

| CONTROLS | | POWER SOURCE | | | | POWER OFF | |
|---|---|---|---|---|---|---|---|
| TITLE | POSITIONS | BUS 1 (cb direct) | BUS 2 (LOGIC 2/3 PWR sw) | BUS 3 (LOGIC 2/3 PWR sw) | BUS 4 (cb direct) | OPEN CIRCUIT | SWITCHED OFF BY |
| CMC ATT | IMU | X | | | X | | cb SCS LOGIC 1/2, 1/4, & 3/4 |
| | GDC | | | | | X | |
| FDAI SCALE | 5/1 | | | | | X | |
| | 5/5 | | X | | | | LOGIC 2/3 PWR |
| | 50/15/50/10 | | | | X | | cb SCS LOGIC 1/4 & 3/4 |
| FDAI SEL | 1/2 | | | | X | | cb SCS LOGIC 1/4 & 3/4 |
| | 1 | | | X | | | LOGIC 2/3 PWR |
| | 2 | | | X | | | LOGIC 2/3 PWR |
| FDAI SOURCE | CMC | | X | | | | LOGIC 2/3 PWR |
| | ATT SET | | | X | | | LOGIC 2/3 PWR |
| | GDC | | | X | | | LOGIC 2/3 PWR |
| ATT SET | IMU | | X | | | | LOGIC 2/3 PWR |
| | GDC | | | | X | | cb SCS LOGIC 1/4 & 3/4 |
| MAN ATT (3) | ACCEL CMD | X | | | | | cb SCS LOGIC 1/2 & 1/4 |
| | RATE CMD | | | | | X | |
| | MIN IMP | X | | | | | cb SCS LOGIC 1/2 & 1/4 |
| LIM CYCLE | on (up) | | | | | X | |
| | OFF | X | | | | | cb SCS LOGIC 1/2 & 1/4 |
| ATT DBD | MAX | | | | | X | |
| | MIN | X | | | | | cb SCS LOGIC 1/2 & 1/4 |
| RATE | HI | X | | | | | cb SCS LOGIC 1/2 & 1/4 |
| | LO | | | | | X | |

Figure 4.6-3. SCS Logic Bus Power Distribution (Sheet 1 of 2)

| CONTROLS | | POWER SOURCE | | | | POWER OFF | |
|---|---|---|---|---|---|---|---|
| TITLE | POSITIONS | BUS 1 (cb direct) | BUS 2 (LOGIC 2/3 PWR sw) | BUS 3 (LOGIC 2/3 PWR sw) | BUS 4 (cb direct) | OPEN CIRCUIT | SWITCHED OFF BY |
| SC CONT | CMC | | X | | | | LOGIC 2/3 PWR |
| | SCS | | | X | | | LOGIC 2/3 PWR |
| BMAG MODE | RATE 2 | | (R) | (P & Y) | | | LOGIC 2/3 PWR |
| | ATT 1/RATE 2 | | (R) | (P & Y) | | | LOGIC 2/3 PWR |
| | RATE 1 | (R,P,Y) | | | | | cb SCS LOGIC 1/2 & 1/4 |
| DIR ULL | pb | X | | | | | cb SCS LOGIC 1/2 & 1/4 |
| THRUST ON | pb | X | | | | | cb SCS LOGIC 1/2 & 1/4 |
| GDC ALIGN | pb | | | | X | | cb SCS LOGIC 1/4 & 3/4 |
| SCS TVC (2) | AUTO | | | X | | | LOGIC 2/3 PWR |
| | RATE CMD | | | X | | | LOGIC 2/3 PWR |
| | ACCEL CMD | | | X | | | LOGIC 2/3 PWR |
| ΔV CG | LM/CSM | | | X | | | LOGIC 2/3 PWR |
| | CSM | | | | | X | LOGIC 2/3 PWR |
| EMS ROLL | on (up) | | | | X | | cb SCS LOGIC 1/4 & 3/4 |
| | OFF | | | | | X | |
| .05 G sw | on (up) | | | | X | | cb SCS LOGIC 1/4 & 3/4 |
| | OFF | | X | | | | LOGIC 2/3 PWR |
| TVC GMBL DR (2) | 1 | | | | | X | |
| | AUTO | X | | | | | cb SCS LOGIC 1/2 & 1/4 |
| | 2 | | | X | | | LOGIC 2/3 PWR |
| THC | CW sw | | X | | | | LOGIC 2/3 PWR |

Figure 4.6-3. SCS Logic Bus Power Distribution (Sheet 2 of 2)

### CAUTION

SCS logic bus power must not be removed from CMC ATT switch if (1) pitch or yaw rate >5°/second, or (2) GDC yaw Euler angle >80° and <280°. Removing power when either of these conditions exist will result in GDC damage.

4. LIMITED USE CONTROLS: G&C circuit breakers, required for G&C operation, are to be closed during the entire mission except in event of malfunctions. (See figure 4.6-4.) If a malfunction occurs, some circuit breakers may be operated in order to isolate problem areas. Refer to malfunction procedures, section 5.2.

   Figure 4.6-5 defines switches which will remain in same position during major portion of orbital flight time because of functional requirements. Other considerations are to maintain maximum crew safety, increase equipment reliability, and minimize power consumption.

5. ATT SET - IMU FUNCTION: If CMC is on, an overload in IMU resolver circuitry may cause an ICDU oscillation and trigger the ISS warning light (Reference ICD MH01-01325-216). FDAI must be used only as a null meter in this mode of operation. If not, large errors will result because of impedance mismatch. ATT SET switch should be left at GDC when not in use.

   A polarity reversal occurs when ATT SET - IMU option is selected, and roll gimbal angle $\geq \pm 90°$. The pitch and yaw attitude error needles become "fly from" indicators rather than "fly to" indicators in this instance.

6. LOGIC 2/3 PWR switch: Required "on" for proper control/display functions (G&N or SCS modes). See figure 4.6-3 for switches whose positions are dependent on this switch being on for proper system operation.

7. MANEUVER >17°: For CMC maneuvers >17° and during SIVB maneuvers, the BMAGs should be caged to prevent them from hitting their stops.

The G&C circuit breakers listed in this chart must be closed throughout the mission except when necessary to correct a malfunction.

- Panel 8
  - SCS
    - TVC AC1
    - AC (both)
    - ECA/TVC AC2
    - DIR ULL (2)
    - CONTR DIR (4)
    - CONTR AUTO (2)
    - LOGIC (all)
    - SYS (2)
    - A/C ROLL (2)
    - B/D ROLL (2)
    - PITCH (2)
    - YAW (2)
  - ORDEAL (2)
  - EMS (2)
  - RCS
    - SM HTRS (4)
    - PRPLNT (2)
  - SPS (12)

- Panel 5
  - G/N
    - PWR AC (both)
    - IMU (2)
    - IMU HTR (2)
    - CMPTR (2)
    - OPT (2)

- Panel 229
  - EPS
    - GRP 1 (both)
    - GRP 2 (both)
    - GRP 3 (both)
    - GRP 4 (both)
    - GRP 5 (both)

Figure 4.6-4. Limited Use G&C Circuit Breakers

| Switch | Location | Position Major Portion of Mission | When Required | Remarks |
|---|---|---|---|---|
| CMC ATT | MDC-1 | IMU | Normally not touched | Selection of GDC position causes total attitude display to be lost on both balls. Must not be moved to GDC position if (1) pitch or yaw rate is >5 deg/sec, or (2) GDC yaw Euler angle >80° and <280°. GDC damage will result if this is done. |
| IMU CAGE (guarded) | MDC-1 | off (down) | To establish an inertial reference in event of CSS failure or IMU tumbling. | Cage mode zeros the IMU gimbals in a coarse alignment. |
| EMS ROLL | MDC-1 | OFF | Prior to entry | Refer to Entry and Entry Preparation Procedures. |
| .05 G sw | MDC-1 | OFF | At .05 G during entry | Except for entry, on (up) position not desirable (cages BMAGs). Off position powered by LOGIC 2/3 PWR - on (up). |
| α/Pc IND sw | MDC-1 | Pc | Following launch tower jettison | Left in Pc position after tower jettison. |
| LV IND/GPI sw | MDC-1 | GPI | Prior to SPS thrusting | Placed in SII/SIVB position during Prime Crew Prelaunch. Temporarily placed in GPI position for SPS gimbal check at lift off +6 minutes. |
| LV GUID | MDC-2 | IU | If manual inputs to the SIVB control system are required | Nonfunctional after separation from SIVB. |
| UP TLM | LEB-122 | ACPT | Not normally changed | Both UP TLM switches (MDC-2, LEB 122) must be in ACPT position for CMC to accept telem data. MDC-2 switch normally used as control. |

Figure 4.6-5. Limited Use Controls

8. ACCEL CMDs: Acceleration commands are available, via RHCs, any time MAN ATT switches are at ACCEL CMD (SC CONT - CMC or SCS). However, ACCEL CMD position inhibits any CMC outputs to RCS jets.

9. EMS MODE switch: EMS MODE switch should be placed to NORM <30 seconds prior to thrusting to minimize buildup of ΔV indicator errors, caused by accelerometer bias. Errors also minimized if set to STBY immediately after thrusting. Otherwise, ΔV ind continues counting.

10. MAN ATT/BMAG MODE switches: Switches may be set by axis, as desired.

11. SPS GMBL MOTORS: Start motors sequentially at ≈1-second intervals to avoid electrical overload. Turn GMBL MOT switches OFF sequentially to avoid power surge. Turning servo 2 off first minimizes switching in the logic.

12. (R02) IMU STATUS check: Procedure prerequisites signify when ISS should be on and a known orientation required. Assuming that prerequisites have been complied with, program alarm for R02 should not occur. If prerequisites are not complied with, program alarm for ISS not on and/or IMU orientation unknown is treated as shown in 4.8.1.16.

13. CMC ATT switch: Normally left at IMU position throughout mission. Selection of GDC position causes total attitude display to be lost on both balls. GDC damage will result if GDC position selected and pitch or yaw rate is >5 deg/sec, or if GDC yaw Euler angle is >80° and <280°.

### 4.6.1.2 SCS Operations

1. SCS RATE/DEADBAND: During SCS attitude control modes (4.7.1), ATT DBD and RATE switch positions establish rate and deadband response. (See figure 4.6-6.) For FDAI scaling, see figure 4.6-7. Refer to 4.8.2.1 for selection of CMC controlled rate and deadband.

2. SCS JET SEL: Sixteen AUTO RCS switches, consisting of four switch groups titled A/C ROLL, B/D ROLL, PITCH, and YAW with four switches each, enable CM and/or SM jets. Panel nomenclature for AUTO RCS switches summarizes jet characteristics for both SM and CM RCS jets. See figure 4.6-8. Refer to 4.6.1.3, note 1d, and 4.8.2.1 for CMC jet selection.

3. INADVERTENT JET FIRINGS: When powering up SCS, BMAGs should be caged to prevent inadvertent firings of RCS jets.

4. PSEUDO RATE: The pseudo rate function, controlled by LIM CYCLE switch, is used only during SCS attitude hold mode to conserve RCS propellants. However, manual SCS maneuvers with LIM CYCLE switch on cause excessive RCS injector valve cycling and increased propellant consumption. Switch does not function when in computer (CMC) mode. Also refer to note 6.

5. SIG CONDR/DR BIAS PWR switch: Powers RJEC -4 vdc bias power supplies and various SCS signal conditioners for telemetery. To provide increased reliability, switches should not be set on same bus.

6. LIM CYCLE switch: For SCS modes, LIM CYCLE switch should be configured as follows in order to conserve RCS propellant:

   OFF - Manual proportional rate command.
   OFF - Automatic rate damping.
   on (up) - Attitude hold.

7. BMAG PWR switch: When BMAG PWR switches set to OFF, 40-minute warmup may be required (BMAG 1 & 2 TEMP lights out when operating temperature reached) before normal operation of BMAGs. If set from ON to WARMUP, BMAG TEMP lights should remain out.

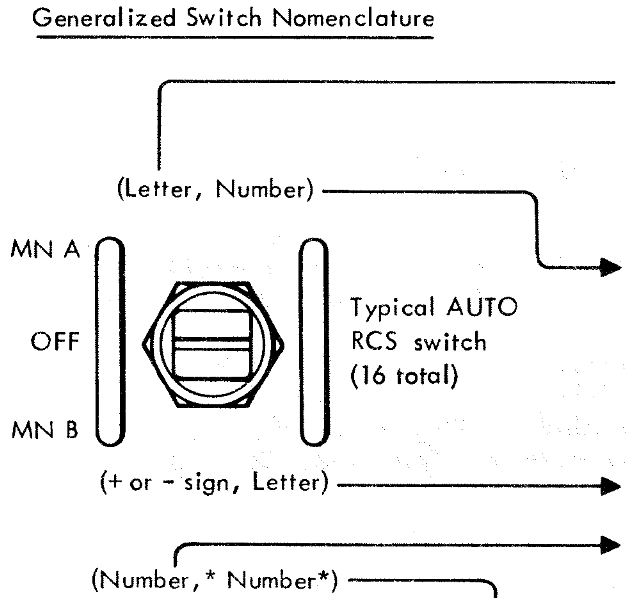
| Control Parameter | | SWITCH POSITIONS | | | |
|---|---|---|---|---|---|
| | | RATE - LOW* | | RATE - HIGH | |
| | | ATT DBD: | | ATT DBD: | |
| | | MIN | MAX* | MIN | MAX |
| Attitude Deadband | | ±0.2° | ±4.2° | ±4.0° | ±8.0° |
| Commanded Rates | Pitch & Yaw | ±0.7°/sec | | ±7.0°/sec | |
| | Roll | | | ±20.0°/sec | |
| Rate Deadband | | ±0.2°/sec | | ±2.0°/sec | |

*Recommended position to minimize fuel consumption during attitude hold.

Figure 4.6-6. SCS Rate and Deadband Select Logic

| FDAI SCALE SW POS | ATT ERROR | | | |
|---|---|---|---|---|
| | FLIGHT PHASE | CMC | SCS | SCS RATES |
| 5/1 | Boost & entry | R 20°<br>P&Y 5° | RP&Y 5° | RP&Y 1°/sec |
| | All other | RP&Y 5° | RP&Y 5° | RP&Y 1°/sec |
| 5/5 | Boost & entry | R 20°<br>P&Y 5° | RP&Y 5° | RP&Y 5°/sec |
| | All other | RP&Y 5° | RP&Y 5° | RP&Y 5°/sec |
| 50/15, 50/10 | Boost & entry | R 50° | R 50° | R 50°/sec |
| | | P&Y 15° | P&Y 15° | P&Y 10°/sec |
| | All other | R 12.5° | R 50° | R 50°/sec |
| | | P&Y 15° | P&Y 15° | P&Y 10°/sec |

Figure 4.6-7. FDAI Scaling



| Code | Description |
|---|---|
| A, B, C or D | SM RCS Quad Designation<br>A is –Z Quad<br>B is +Y Quad<br>C is +Z Quad<br>D is –Y Quad |
| 1, 2, 3, or 4 | Individual SM RCS Jet Designation<br>1 and 2 are roll jets<br>3 and 4 are quad A/C pitch jets or quad B/D yaw jets<br>Odd nos. (1 and 3) indicate + rotation<br>Even nos. (2 and 4) indicate – rotation |
| ±X, ±Y, ±Z | Translation Axis and Direction Designation |
| 1 or 2 | CM RCS System Designation<br>1 is primary system<br>2 is backup system |
| 1, 2, 3, 4, 5 or 6 | Individual CM RCS Jet Designation<br>1 and 2 are roll jets<br>3 and 4 are pitch jets<br>5 and 6 are yaw jets<br>Odd nos. (1, 3 and 5) indicate positive rotation<br>Even nos. (2, 4 and 6) indicate negative rotation |

*No number means switch is not applicable to CM RCS system (enables only SM RCS A/C roll jets)

SM-2A-1428C

Figure 4.6-8. SCS Jet Select Logic: MDC-8 Nomenclature

### 4.6.1.3 G&N Operations

1. GENERAL:

   a. IMU STBY PWR: If standby power is removed for more than 20 minutes, ISS calibration is no longer valid.

   b. CMC CONTROLLED MANEUVERS: During CMC controlled maneuvers, any input from RHC (RHC out of detent) will be interpreted by CMC as a manual override and will cause immediate termination of auto maneuver calculation.

   c. VEC POINT ROUTINE: VEC POINT routine (all CMC auto maneuvers except in P23 and R62) may compute large OGA (roll) required when +X must be rotated ≈180°. Sensitivity to such changes gets greater as magnitude increases toward 180°. If desired, a manual maneuver in pitch ≈30° is performed and the solution is then recomputed by keying PRO on FL V50 N18 while not in CMC/AUTO.

   d. CMC JET SEL: CMC jet selection is accomplished by performing procedure 4.8.2.1, V48 (R03, DAP Data Load). AUTO RCS switches should correspond to RCS DAP configuration. During SPS thrusting, configuration for AUTO RCS roll enable should agree with RCS DAP load to reduce SPS propellant slosh in event of a failed-on roll jet.

   e. IMU GMBL LOCK: If non-G&N controlled attitude maneuvers are made by crew, care must be taken to avoid IMU gimbal lock. IMU gimbal angles may be monitored by observing ICDUs (V16 N20) or by monitoring FDAI ball.

   f. CMC PWR: If computer power is switched off, it will be necessary to perform a computer fresh start (V36E) to initialize erasable storage. CMC update program (P27) would have to be done to update the state vector and computer clock time.

   g. CLOCK TIME (GET): CMC is capable of maintaining an accurate value of ground elapsed time (GET) for only 23 hours when in standby mode. If CMC is not brought out of standby condition to running condition at least once within 23 hours, CMC value of GET must be updated.

h. IMU ORIENTATION (P51): Time and RCS prplnt may be saved, and subsequent IMU alignment decisions greatly simplified if P51 is performed in such a way as to leave IMU inertially stabilized at an orientation as close as possible to optimum orientation required by future CMC programs.

2. CSS/ISS INTERFACE: Normally the CMC must be ON before the IMU can be operated. However, the IMU may be powered up while the CMC is at STBY. In this condition, the IMU is caged (if powered up) and remains in a coarse align mode. Caging is accomplished internally and does not require any panel switching. However, if the CMC is at STBY, the IMU can be uncaged by placing the IMU CAGE switch to on (up) for ≈5 seconds. V37 should not be called for 15 seconds after NO ATT light goes out. If V37 is called prior to 15 seconds, the PIPA FAIL bit will not be reset and a PIPA FAIL will go undetected.

3. DSKY OPERATIONS: DSKY operations (MDC-2 and LEB-140) require certain restrictions to operation, loading of data, and display of data which are necessary to proper operation. Some general restrictions are listed below. Detailed information relative to DSKY operations is contained in MIT Report E-2129, "Keyboard and Display Program and Operation."

a. DISPLAY/MONITOR VERBS: For display verbs (01-07), monitor verbs (11-17), and for all load verbs (21-25), the number of components of the verb must not exceed the number of components of the noun being used beginning with noun 04. Noun 01, 02, and 03 may be used with any verb regardless of number of components. If an attempt is made to violate this restriction, the OPR ERR indicator will illuminate when ENTR is pressed to execute the verb/noun action.

b. OCTAL/DECIMAL MIXING: No mixing of octal and decimal data will be allowed for loads having more than one component. If an attempt is made to violate this restriction, the OPR ERR indicator will illuminate when ENTR is pressed for the last entry.

c. DECIMAL/OCTAL LOADS: Octal data loads require only significant digits be keyed (e.g., 5, 4, ENTR). Loading decimal data requires each complete entry be made with a sign (+, -), followed by significant digits. Decimal load of less than 5 digits will be accepted, just as an octal load. Zeros need not be entered ahead of most significant digit. (E.g., for a data load of +925, entry will be made by pressing DSKY keys +, 9, 2, 5, ENTR, and +, ENTR rather than +, 0, 0, 0, 0, 0, ENTR.) When loading decimal data. ENTR sometimes changes last digit of loaded value.

d. MACHINE ADDRESSES: Machine addresses must be loaded in octal.

e. DATA LOAD: If an attempt is made to load a data word which is too large in magnitude for the noun being used, the OPR ERR indicator will illuminate.

All data loads must be verified before pressing ENTR key for last register being loaded. (CLR key has no effect after last ENTR is pressed.) If any of the data is incorrect, register may be cleared by pressing CLR key. Each successive pressing of CLR key will clear preceding register until first register is cleared. (This backing up action will only operate on components called by load verb used.)

f. VERB/NOUN FLASHES: All VERB/NOUN flashes require operator action and the program in progress is halted until appropriate action is taken.

g. PROGRAM SELECTIONS: At times when program selection is not allowable by astronaut action (V37E XXE), R00 will issue a program alarm (01520) and interrupted activity will resume. Attempts to select nonexistent programs will result in an operator error light and return to interrupted program activity and display.

h. PROGRAM TERMINATION: Any program can be terminated at a flashing display via V34E except:

- When P20 is running in background of another program, a V34E on a P20 display (R60 or N49 in R22) will terminate P20 only. Conversely, a V34E on a prethrust program will turn off that program but not P20.
- V34E with an extended verb running will terminate the extended verb only.
- V34E is ignored in P06.

i. V96E: V96E may cause significant loss of W-matrix correlation if keyed in:

- After a V37E XXE from a program using average G and before XX appears in PROG lights.
- During a permanent state vector integration in P20 during mark processing.

To recover, V93E is keyed at some time prior to next navigation marks or VHF range input. In all other cases, use of V96E will cause no ill effects providing next program selected is P00.

j. V82E: After V82E, meaningful information in N50 (splash error) is available only during P11 and P00.

k. EXTENDED VERBS: Extended verbs are not restart-protected. If RESTART light goes on during an extended verb, or if software restart occurs (no RESTART light), the verb should be reselected.

l. VG/ΔV DISPLAYS: VG or ΔV displays in control coordinates, N85 or N83, are based on reading accelerometers every 2 seconds. Displays, however, are asynchronous 1-second monitors. Result is a possible 1/2- to 1-1/2-second delay between application of ΔV and visible result.

m. PRO KEY: A PRO key input is rejected if verb windows show a V21, V22, or V23. V33E must be used for these cases, e.g., a V21 PRO (or V25E PRO) will be rejected; a V25 PRO will not. For the V21, V22, V23 and PRO cases, PRO lights OPR ERR light.

n. KEY REL pb/KEY REL lt: Normal and special cases of KEY REL light and KEY REL push-button use are discussed in the following notes.

KEY REL lt - on

- When internal display comes up while operator has DSKY.
- When internal flashing display is currently on DSKY and keystroke is made except for PRO, ENTR, and ERR RSET.

- Suspended monitor: When operator makes keystroke on top of (his own) monitor verbs (verbs 11-17).
- Remains on after V37 until new program is started. Operator should not use keyboard until KEY REL light is out and new program number is displayed.

o. KEY REL lt - out

- When operator relinquishes DSKY by pressing KEY REL.
- When operator terminates his current sequence normally by:

Final ENTR of load sequence

or ENTR, after a response to a flashing display (V34E)

or ENTR, after an extended verb request (V49E).

p. Special cases of KEY REL

- If operator selects a nonmonitor verb display on top of his own previously selected monitor verb, the KEY REL light will flash. Pressing KEY REL will bring back (unsuspend) the monitor and extinguish light. However, if these sequences are performed on top of an internal display, the KEY REL light will not go out when KEY REL is pressed. One more KEY REL operation (total of two) is required to extinguish KEY REL light, and bring back the internal display.
- If operator selects a verb-noun combination (i.e., V16 monitor) on top of an internal flashing display, the internal display can still be answered with V32E, PRO, or V34E, which wipes everything from the DSKY until the next internal display. However, an operator-selected monitor should, as a rule, never be terminated with V34E. V34E may not be the desired response to the internal flashing display. KEY REL should be used instead. KEY REL need not be used if a data load is interrupted by a priority display.

4. OPTICS MECHANIZATION: Operation of the SCT and SXT requires adherence to certain constraints which are described as follows:

a. To avoid sun interference, the sun position must be more than 10 degrees from optics shaft-drive axis and more than 15 degrees from star LOS for SXT, and more than 55 degrees from shaft-drive axis for SCT. Within these limits it is possible to use SXT even when sun position is between the SLOS and LLOS. The constraints given, however, do not take into account light scattering which can occur from actual spacecraft configuration.

b. An adequate portion of the star field must be visible through SCT in order that navigational stars can be recognized. The optics shaft-drive axis thus must be pointed at least 30 degrees above local sunlit earth horizon and at least 20 degrees above local dark earth horizon.

c. Maximum SXT LOS drive rates are 10 deg/sec for trunnion and 19.5 deg/sec for shaft, with a ±20 percent tolerance. During landmark tracking from a 100-nautical mile earth orbit, in order to be able to maintain optics LOS within the capability of shaft-drive rate, optics LOS to the landmark must be >8.5 degrees from optics shaft-drive-axis ground track at closest point of approach of landmark to shaft-drive-axis ground track. Within this constraint, landmarks on spacecraft ground track can be used by simply rolling CSM so that optic LOS is >8.5 degrees from optics shaft-drive-axis LOS.

d. TRACKER caution light should be ignored during TVC. Optics CDU fail during TVC, sets TRACKER light which will stay on (even with fail removed) until end of TVC or keying RSET.

e. During auto optics, computation lag between sampling IMU CDUs and driving optics causes optics to lag behind target. Amount of offset is proportional to CSM angular rate. At usual rate of 4 deg/min, maximum offset would be 0.133°. This will not cause an error during manual tracking and marking.

f. After a fresh start, or restart, or after turning optics power on, optics must be taken out of zero and returned to zero to perform an optics zero since it is not position of switch but change to zero position that triggers zeroing program.

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.6.2 VERB LIST | | |
| | Regular Verbs | | |
| | 01 Disp oct compnt 1 (R1) | | |
| | 02 Disp oct compnt 2 (R1) | | |
| | 03 Disp oct compnt 3 (R1) | | |
| | 04 Disp oct compnt 1, 2 (R1, R2) | | |
| | 05 Disp oct compnt 1, 2, 3 (R1, R2, R3) | | |
| | 06 Disp dec (R1 or R1, R2 or R1, R2, R3) | | |
| | 07 Disp DP dec - test only (R1, R2) | | |
| | 11 Mon oct compnt 1 (R1) | | |
| | 12 Mon oct compnt 2 (R1) | | |
| | 13 Mon oct compnt 3 (R1) | | |
| | 14 Mon oct compnt 1, 2 (R1, R2) | | |
| | 15 Mon oct compnt 1, 2, 3 (R1, R2, R3) | | |
| | 16 Mon dec (R1 or R1, R2 or R1, R2, R3) | | |
| | 17 Mon DP dec - test only (R1, R2) | | |
| | 21 Load compnt 1 (R1) | | V33E must be used for accept option if V21, V22, or V23 is in verb window. PRO is not accepted and turns on OPR ERR light. |
| | 22 Load compnt 2 (R2) | | |
| | 23 Load compnt 3 (R3) | | |
| | 24 Load compnt 1, 2 (R1, R2) | | |
| | 25 Load compnt 1, 2, 3 (R1, R2, R3) | | |
| | 27 Disp fixed memory | | |
| | 30 Request exec | | Use in P00 only. |
| | 31 Request waitlist | | Use in P00 only. |
| | 32 Recycle | | |
| | 33 Proceed | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 34 | Terminate | | |
| 35 | Test lights | | Use in P00 only. |
| 36 | Req fresh strt | | Blanks DSKY displays. May compromise stored state vector requiring a P27 update and IMU orientation determination. |
| 37 | Change prog (major mode) | | |
| | Extended Verbs | | |
| *40 | Zero CDU (with N20) | | Ensures sync between ISS CDU counters and CDU counters in CMC. Terminates coarse align and enters fine align. |
| 41 | Coarse align CDU (with N20 & N91) | | N20 - Aligns IMU to gimbal angles specified by crew. To coarse align to 0, 0, 0 when GMBL LOCK and coarse align. N91 - To drive optics to shaft and trunnion angles specified by crew (V41 N91 from P00 only). |
| 42 | Pulse torque gyro | | Fine align IMU. |
| 43 | Load FDAI att err needles (test only) | | P00 only. |
| *44 | Set surface flag | | |
| *45 | Rset surface flag | | |
| *46 | Activate DAP | | |
| *47 | Set LM state vctr into CSM state vctr | | |
| 48 | Strt DAP data load (R03) | | Calls up routine 03. |
| 49 | Strt crew defined mnvr (R62) | | P00 only. |
| 50 | Please perform | | |
| 51 | Please mrk | | |

*Callable with another extended verb in use & does not lock out other extended verbs.

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| *52 | Marked on offset ldg site (P22) | | |
| 53 | Please mrk alternate LOS | | |
| 54 | Strt rndz backup sighting mrk (R23) | | |
| 55 | Increment CMC time (dec) | | |
| *56 | Term tracking (P20) | | |
| 57 | Strt rndz sighting mrk (R21) | | |
| *58 | Rset stick flag, set V50 N18 flag | | Allows auto maneuvers. |
| 59 | Please mrk (opt calib) | | |
| *60 | Set att err ref to present att | | |
| *61 | Sel mode 1 (disp DAP att err) | | Mode 1. FDAI error needles show difference between current and DAP commanded ICDU angles. |
| *62 | Sel mode 2 (disp tot att err) | | Mode 2. Display difference between desired final ICDUs (N22) and present ICDUs (N20) resolved into CSM control axes. |
| *63 | Disp tot astronaut att err | | Mode 3. Display difference between astronaut total attitude (N17) and present ICDUs (N20) resolved into CSM control axes. |
| 64 | Strt S-bd ant routine (R05) | | |
| *65 | Strt opt verif of prelaunch align - P03 | | V65E calls for P03 (during P02 only). |
| *66 | Set CSM state vctr into LM state vctr | | |
| 67 | Strt W matrix RSS err disp | | |
| *69 | Restrt | | |
| 70 | Strt CMC update - liftoff time (P27) | | V70 through V73 are allowed only during P00 or P02. |
| 71 | Strt CMC update - block ADR (P27) | | |
| 72 | Strt CMC update - single ADR (P27) | | |
| 73 | Strt CMC update - CMC time (P27) | | |

*Callable with another extended verb in use & does not lock out other extended verbs.

VERB LIST

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| *74 | Init erasable dump via downlink | | |
| *75 | Backup liftoff | | |
| *76 | Set pref att flag | | |
| *77 | Rset pref att flag | | |
| *78 | Update prelaunch az | | |
| 79 | Req orbrate/PTC (BBQ mode - R64) | | |
| *80 | Enbl LM state vctr update | | |
| *81 | Enbl CSM state vctr update | | |
| 82 | Req orb param disp (R30) | | V82E calls R30. |
| 83 | Req rndz param disp #1 (R31) | | V83E calls R31. V83 and V85 displays will be meaningless at altitudes >432 NM for both earth and moon if exercised during periods of precision vector integration. |
| 85 | Req rndz param disp #2 (R34) | | V85E calls R34. |
| *86 | Reject rndz backup sighting mrk | | |
| *87 | Set VHF range flag | | |
| *88 | Rset VHF range flag | | |
| 89 | Strt rndz fnl att routine (R63) | | V89E calls R63 from P00 only. |
| 90 | Req rndz out of plane disp (R36) | | V90E calls R36. |
| 91 | Banksum | | P00 only. |
| *93 | Enbl W matrix init | | |
| *94 | Enbl cislunar tracking recycle (P23) | | |
| *96 | Term integration & go to P00. | | |
| 97 | SPS thrust fail (R40) | | |
| 99 | Enbl eng ign | | |

*Callable with another extended verb in use & does not lock out other extended verbs.

| STA/T STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.6.3 NOUN LIST | | | All nouns may be loaded via DSKY entry. However, registers containing units of XXBXX cannot be loaded and nouns containing such register data cannot be loaded by V24 or V25. |
| 01 | Specify address (fract) | | .XXXXX<br>.XXXXX<br>.XXXXX | |
| 02 | Specify address (whole) | | XXXXX.<br>XXXXX.<br>XXXXX. | |
| 03 | Specify address (deg) | | XXX.XX<br>XXX.XX<br>XXX.XX | |
| +05 | Angular err/diff | | XXX.XX DEG | |
| +06 | Option code ID | | OCT | |
| | Option code | | OCT | |
| +07 | Flagword | ECADR | OCT | ECADR ≤30 (octal) will select appropriate channel (except that channel 7 attempts will be ignored). |
| | | BIT ID | OCT | |
| | | ACTION | OCT | |
| 08 | Alarm data | ADRES | OCT | |
| | | BBCON | OCT | |
| | | ERCOUNT | OCT | |
| 09 | Alarm codes | FIRST | OCT | |
| | | SECOND | OCT | |
| | | LAST | OCT | |
| 10 | Chan to be specified | | OCT | |
| 11 | GETI (CSI) | | 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | |

+Nouns not manually callable with valid data at any time.

NOUN LIST

| STA/T STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|
| +12 | Option code | | OCT | Used only with extended verbs. |
| | | | OCT | |
| 13 | GETI (CDH) | | 00XXX. HRS | |
| | | | 000XX. MIN | |
| | | | 0XX.XX SEC | |
| 15 | Increment address | | OCT | Used with N01, N02, and N03. |
| +16 | Time of event | | 00XXX. HRS | Used by extended verb only. |
| | | | 000XX. MIN | |
| | | | 0XX.XX SEC | |
| 17 | Astronaut tot | R | XXX.XX DEG | Used in Mode 3 needles (V63). |
| | att | P | XXX.XX DEG | |
| | | Y | XXX.XX DEG | |
| 18 | Auto mnvr | R | XXX.XX DEG | |
| | | P | XXX.XX DEG | |
| | | Y | XXX.XX DEG | |
| 20 | ICDU angles | OG-R | XXX.XX DEG | |
| | | IG-P | XXX.XX DEG | |
| | | MG-Y | XXX.XX DEG | |
| 21 | PIPAS | X | XXXXX. Pulses | |
| | | Y | XXXXX. Pulses | |
| | | Z | XXXXX. Pulses | |
| 22 | New ICDU angles | OG-R | XXX.XX DEG | |
| | | IG-P | XXX.XX DEG | |
| | | MG-Y | XXX.XX DEG | |
| +24 | Δ time for | | 00XXX. HRS | V25 N24 display initiated by V55E. |
| | CMC clock | | 000XX. MIN | |
| | | | 0XX.XX SEC | |
| +25 | Checklist | | XXXXX. | Used with V50. |
| +26 | Prio/delay | | OCT | Used with V30, V31. |
| | ADRES | | OCT | |
| | BBCON | | OCT | |

+Nouns not manually callable with valid data at any time.

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 27 | Self-test on/off sw | XXXXX. | |
| +29 | X SM launch az | XXX.XX DEG | |
| +30 | Trgt code (gyro compassing verif) | XXXXX.<br>XXXXX.<br>XXXXX. | |
| 32 | TF perigee | 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | Time from perigee/perilune. |
| 33 | GETI | 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | GETI - ground elapsed time of ignition. |
| +34 | Time of evnt | 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | |
| 35 | Time from evnt | 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | |
| 36 | Time of CMC clock | 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | |
| 37 | GETI (TPI) | 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | |
| 38 | Time of state vctr | 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | |
| 39 | ΔT for trnfr | 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | |
| 40 | TF GETI/TFC<br>VG<br>ΔV (accum) | XXBXX MIN-SEC<br>XXXX.X FPS<br>XXXX.X FPS | This is a no load noun (OPR ERR). |

+Nouns not manually callable with valid data at any time.

NOUN LIST

| STA/T STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|
| +41 | Trgt | Az | XXX.XX DEG | N41 - 2 component noun. |
| | | Elev | XX.XXX DEG | |
| | | ID | 0000X. | |
| 42 | Ha | | XXXX.X NM | Apogee/apolune altitude. |
| | Hp | | XXXX.X NM | Perigee/perilune altitude. |
| | ΔV (req) | | XXXX.X FPS | |
| 43 | Lat (+N) | | XXX.XX DEG | |
| | Long (+E) | | XXX.XX DEG | |
| | Alt | | XXXX.X NM | |
| 44 | Ha | | XXXX.X NM | Apogee altitude. This is a no load noun (OPR ERR). |
| | Hp | | XXXX.X NM | Perigee altitude. |
| | TFF | | XXBXX MIN-SEC | Time of freefall to 49.4 NM (300,000 ft) above launch pad radius for earth orbit, or for lunar orbit, 5.8 NM (35,000 ft) above lunar radius at most recently defined lunar landing site. |
| 45 | Mrks (VHF/opt) | | XXBXX MKS | This is a no load noun (OPR ERR). |
| | TF GETI (next burn) | | XXBXX MIN-SEC | |
| | MGA | | XXX.XX DEG | |
| 46 | DAP config | | OCT | Loads configuration for use by DAPS. |
| | | | OCT | |
| 47 | CSM wt | | XXXXX. LB | Loads vehicle weights for use by DAPs. |
| | LM wt | | XXXXX. LB | |
| 48 | Pitch trim | | XXX.XX DEG | Loads pitch and yaw trim angles. |
| | Yaw trim | | XXX.XX DEG | |
| 49 | ΔR | | XXXX.X NM | |
| | ΔV | | XXXX.X FPS | |
| | Code | | 0000X. | |

+Nouns not manually callable with valid data at any time.

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 50 | Splash err | XXXX.X NM | Negative for undershoot, positive for overshoot. This is a no load noun (OPR ERR). |
| | | Hp | XXXX.X NM | |
| | | TFF | XXBXX MIN-SEC | Time of freefall. |
| | 51 | Rho | XXX.XX DEG | |
| | | Gamma | XXX.XX DEG | |
| | 52 | CENTANG (active veh) | XXX.XX DEG | Central angle of active vehicle. |
| | 53 | Range | XXX.XX NM | |
| | | Range rate | XXXX.X FPS | |
| | | Phi (lcl horiz/SLOS) | XXX.XX DEG | 0 to 180° = SLOS above plane. |
| | 54 | Range | XXX.XX NM | Range to LM. |
| | | Range rate | XXXX.X FPS | |
| | | Theta (lcl horiz/ CSM +X) | XXX.XX DEG | 0 to 180° = +X above plane. |
| | 55 | NN | 0000X. | Display definition depends on using program/routine. |
| | | E | XXX.XX DEG | Elevation. |
| | | CENTANG (passive veh) | XXX.XX DEG | Central angle of passive vehicle. |
| | 56 | Reentry angle | XXX.XX DEG | |
| | | ΔV | XXXXX. FPS | |
| | 58 | Hp (post TPI) | XXXX.X NM | Perigee alt (post TPI). |
| | | ΔV (TPI) | XXXX.X FPS | |
| | | ΔV (TPF) | XXXX.X FPS | |
| | 59 | ΔV LOS 1 | XXXX.X FPS | |
| | | ΔV LOS 2 | XXXX.X FPS | |
| | | ΔV LOS 3 | XXXX.X FPS | |
| | 60 | G max | XXX.XX G | |
| | | V pred | XXXXX. FPS | |
| | | Gamma EI [lcl horiz/VI (+up)] | XXX.XX DEG | |
| | 61 | Impact Lat (+N) | XXX.XX DEG | |
| | | Impact Long (+E) | XXX.XX DEG | |
| | | Hds up/down (+Hds up) | +/-00001. | |

NOUN LIST

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 62 | VI | XXXXX. FPS | Inertial velocity. |
| | H dot | XXXXX. FPS | Altitude rate. |
| | H pad | XXXX.X NM | Altitude above pad radius (earth orbit) or landing site radius (lunar orbit). |
| 63 | RTOGO (.05 G to splash) | XXXX.X NM | One shot display, should always be positive. .05 G represents pad loaded altitude. This is a no load noun (OPR ERR). |
| | VIO (at .05 G) | XXXXX. FPS | Predicted inertial velocity. |
| | TFE (time from .05 G) | XXBXX MIN-SEC | |
| 64 | Drag accel | XXX.XX G | |
| | VI | XXXXX. FPS | Inertial velocity. |
| | Range to splash | XXXX.X NM | Negative and counting down when approaching target; positive and counting up when leaving target. |
| 65 | Sampled CMC time | 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | Fetched in interrupt. |
| 66 | Beta | XXX.XX DEG | Commanded bank angle. |
| | CRSRNG ERR | XXXX.X NM | Positive to right of plane (LATANG +South); negative to left of plane (-North). |
| | DNRNG ERR | XXXX.X NM | Negative for undershoot (PREDANGLE -θ); positive for overshoot. |
| 67 | Range to splash | XXXX.X NM | Negative counting down for approaching target; positive counting up for leaving target. |
| | Lat [Present pos (+N)] | XXX.XX DEG | |
| | Long [Present pos (+E)] | XXX.XX DEG | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 68 | Beta | XXX.XX DEG | Commanded bank angle. |
|  | VI | XXXXX. FPS | Inertial velocity. |
|  | H dot | XXXXX. FPS | Altitude rate. |
| 69 | Beta | XXX.XX DEG | Beta - commanded bank angle. |
|  | DL | XXX.XX G | DL - drag acceleration at end of up-control. |
|  | VL | XXXXX. FPS | VL - velocity at end of up-control. |
| 70 | Star code (before mrk) | OCT |  |
|  | Lmk data | OCT |  |
|  | Horiz data | OCT |  |
| 71 | Star code (after mrk) | OCT |  |
|  | Lmk data | OCT |  |
|  | Horiz data | OCT |  |
| 73 | Alt/10 | XXXXX. NM | On call in P21. |
|  | VI | XXXXX. FPS |  |
|  | Gamma | XXX.XX DEG |  |
| 74 | Beta | XXX.XX DEG |  |
|  | VI | XXXXX. FPS |  |
|  | Drag accel | XXX.XX G |  |
| 75 | Δ alt (CDH) | XXXX.X NM |  |
|  | ΔT (CDH -CSI or TPI -CDH) | XXBXX MIN-SEC |  |
|  | ΔT (TPI -CDH or TPI -NOM TPI) | XXBXX MIN-SEC |  |
| 79 | Rate | X.XXXX DEG/SEC | Used with V79. |
|  | DBD | XXX.XX DEG |  |
|  | Axis option (X or Y) | 0000X. | 0 = X (PTC), non-zero = Y (orbrate). |
| 80 | Time to ign (cutoff) | XXBXX MIN-SEC |  |
|  | VG | XXXXX. FPS |  |
|  | ΔV (accum) | XXXXX. FPS |  |
| 81 | ΔVX (lcl vert) | XXXX.X FPS | (ΔV components). |
|  | ΔVY (lcl vert) | XXXX.X FPS |  |
|  | ΔVZ (lcl vert) | XXXX.X FPS |  |

NOUN LIST

| STA/T STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|
| 82 | ΔVX (lcl vert) | | XXXX.X FPS | |
| | ΔVY (lcl vert) | | XXXX.X FPS | |
| | ΔVZ (lcl vert) | | XXXX.X FPS | |
| 83 | ΔVX (cont) | | XXXX.X FPS | (ΔV components) control = CSM control axes. |
| | ΔVY (cont) | | XXXX.X FPS | |
| | ΔVZ (cont) | | XXXX.X FPS | |
| 84 | ΔVX (other veh) | | XXXX.X FPS | (ΔV components). |
| | ΔVY (other veh) | | XXXX.X FPS | |
| | ΔVZ (other veh) | | XXXX.X FPS | |
| 85 | VGX (cont) | | XXXX.X FPS | (VG vector components) control = CSM control axes. |
| | VGY (cont) | | XXXX.X FPS | |
| | VGZ (cont) | | XXXX.X FPS | |
| 86 | ΔVX (lcl vert) | | XXXXX. FPS | |
| | ΔVY (lcl vert) | | XXXXX. FPS | |
| | ΔVZ (lcl vert) | | XXXXX. FPS | |
| 87 | Mrk data | Shft | XXX.XX DEG | |
| | | Trun | XX.XXX DEG | |
| 88 | Planet | X | .XXXXX | Unit position vector. |
| | | Y | .XXXXX | |
| | | Z | .XXXXX | |
| 89 | Lmk | Lat (+N) | XX.XXX DEG | |
| | | Long/2 (+E) | XX.XXX DEG | |
| | | Alt | XXX.XX NM | |
| 90 | Rndz out of | Y | XXX.XX NM | |
| | plane param | Y Dot | XXXX.X FPS | |
| | | Psi | XXX.XX DEG | |
| 91 | Present OCDU | Shft | XXX.XX DEG | |
| | angles | Trun | XX.XXX DEG | |
| 92 | New OCDU | Shft | XXX.XX DEG | |
| | angles | Trun | XX.XXX DEG | |
| 93 | Δ gyro | X Gyro | XX.XXX DEG | |
| | angles | Y Gyro | XX.XXX DEG | |
| | | Z Gyro | XX.XXX DEG | |

| STA/T STEP | PROCEDURE | | PANEL | REMARKS |
|---|---|---|---|---|
| 94 | Alternate | Shft | XXX.XX DEG | |
| | LOS | Trun | XX.XXX DEG | |
| 95 | Pref att | Roll | XXX.XX DEG | Preferred tracking attitude ICDU angles. |
| | (FDAI | Pitch | XXX.XX DEG | |
| | angles) | Yaw | XXX.XX DEG | |
| 96 | +X axis att | Roll | XXX.XX DEG | |
| | (FDAI | Pitch | XXX.XX DEG | |
| | angles) | Yaw | XXX.XX DEG | |
| +97 | Sys test | | XXXXX. | |
| | inputs | | XXXXX. | |
| | | | XXXXX. | |
| +98 | Sys test | | XXXXX. | |
| | results and | | .XXXXX | |
| | inputs | | XXXXX. | |
| 99 | POS ERR | | XXXXX. FT | RSS value of position error. |
| | VEL ERR | | XXXX.X FPS | RSS value of velocity error. |
| | Option code | | 0000X. | Option code:<br>00001 - Rendezvous<br>00002 - Orbital<br>00003 - Cislunar |

+Nouns not manually callable with valid data at any time.

NOUN LIST

**STA/T STEP** **PROCEDURE** **PANEL** | **REMARKS**

## 4.6.4 STAR LIST

| NO. | STAR NAME (Numerical) | STAR NAME (Alphabetical) | NO. |
|---|---|---|---|
| 1 | Alpheratz | Acamar | 6 |
| 2 | Diphda | Achernar | 4 |
| 3 | Navi | Acrux | 25 |
| 4 | Achernar | Aldebaran | 11 |
| 5 | Polaris | Alkaid | 27 |
| 6 | Acamar | Alphard | 21 |
| 7 | Menkar | Alphecca | 32 |
| 10 | Mirfak | Alpheratz | 1 |
| 11 | Aldebaran | Altair | 40 |
| 12 | Rigel | Antares | 33 |
| 13 | Capella | Arcturus | 31 |
| 14 | Canopus | Atria | 34 |
| 15 | Sirius | Canopus | 14 |
| 16 | Procyon | Capella | 13 |
| 17 | Regor | Dabih | 41 |
| 20 | Dnoces | Deneb | 43 |
| 21 | Alphard | Denebola | 23 |
| 22 | Regulus | Diphda | 2 |
| 23 | Denebola | Dnoces | 20 |
| 24 | Gienah | Enif | 44 |
| 25 | Acrux | Fomalhaut | 45 |
| 26 | Spica | Gienah | 24 |
| 27 | Alkaid | Menkar | 7 |

Vis Mag, Right Ascension and Declination data are relative to the numerical list.

| | Right Ascension | | | Declination | | |
|---|---|---|---|---|---|---|
| Vis Mag | (hr) | (min) | (sec) | (deg) | (min) | (sec) |
| 2.1 | 0 | 06 | 49.9 | +28 | 55 | 29 |
| 2.2 | 0 | 42 | 05.0 | -18 | 09 | 04 |
| Var | 0 | 54 | 53.0 | +60 | 33 | 17 |
| 0.6 | 1 | 36 | 35.9 | -57 | 23 | 20 |
| 2.1 | 2 | 03 | 18.9 | +89 | 07 | 34 |
| 3.4 | 2 | 57 | 07.4 | -40 | 25 | 27 |
| 2.8 | 3 | 00 | 42.5 | +03 | 58 | 23 |
| 1.9 | 3 | 22 | 10.3 | +49 | 45 | 21 |
| 1.1 | 4 | 34 | 11.8 | +16 | 27 | 01 |
| 0.3 | 5 | 13 | 05.7 | -08 | 14 | 06 |
| 0.2 | 5 | 14 | 28.2 | +45 | 58 | 10 |
| -0.9 | 6 | 23 | 17.1 | -52 | 40 | 44 |
| -1.6 | 6 | 43 | 49.6 | -16 | 40 | 25 |
| 0.5 | 7 | 37 | 43.9 | +05 | 18 | 11 |
| 1.9 | 8 | 08 | 36.4 | -47 | 14 | 51 |
| 3.1 | 8 | 57 | 09.7 | +48 | 09 | 38 |
| 2.2 | 9 | 26 | 06.8 | -08 | 31 | 40 |
| 1.3 | 10 | 06 | 46.5 | +12 | 06 | 52 |
| 2.2 | 11 | 47 | 31.8 | +14 | 44 | 23 |
| 2.8 | 12 | 14 | 15.6 | -17 | 22 | 32 |
| 1.0 | 12 | 24 | 54.9 | -62 | 55 | 59 |
| 1.2 | 13 | 23 | 36.6 | -11 | 00 | 19 |
| 1.9 | 13 | 46 | 21.6 | +49 | 27 | 45 |

**STA/T STEP** **PROCEDURE** **PANEL** **REMARKS**

| NO. | STAR NAME (Numerical) | STAR NAME (Alphabetical) | NO. | Vis Mag | Right Ascension (hr) | Right Ascension (min) | Right Ascension (sec) | Declination (deg) | Declination (min) | Declination (sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Menkent | Menkent | 30 | 2.3 | 14 | 04 | 54.6 | -36 | 13 | 23 |
| 31 | Arcturus | Mirfak | 10 | 0.2 | 14 | 14 | 17.5 | +19 | 20 | 16 |
| 32 | Alphecca | Navi | 3 | 2.3 | 15 | 33 | 25.0 | +26 | 48 | 53 |
| 33 | Antares | Nunki | 37 | 1.2 | 16 | 27 | 33.9 | -26 | 22 | 01 |
| 34 | Atria | Peacock | 42 | 1.9 | 16 | 45 | 28.3 | -68 | 58 | 31 |
| 35 | Rasalhague | Polaris | 5 | 2.1 | 17 | 33 | 32.4 | +12 | 34 | 50 |
| 36 | Vega | Procyon | 16 | 0.1 | 18 | 35 | 55.3 | +38 | 45 | 17 |
| 37 | Nunki | Rasalhague | 35 | 2.1 | 18 | 53 | 24.3 | -26 | 20 | 08 |
| 40 | Altair | Regor | 17 | 0.9 | 19 | 49 | 19.1 | +08 | 47 | 16 |
| 41 | Dabih | Regulus | 22 | 3.2 | 20 | 19 | 19.6 | -14 | 49 | 38 |
| 42 | Peacock | Rigel | 12 | 2.1 | 20 | 23 | 17.0 | -56 | 50 | 58 |
| 43 | Deneb | Sirius | 15 | 1.3 | 20 | 40 | 24.4 | +45 | 10 | 21 |
| 44 | Enif | Spica | 26 | 2.5 | 21 | 42 | 42.7 | +09 | 44 | 12 |
| 45 | Fomalhaut | Vega | 36 | 1.3 | 22 | 55 | 59.7 | -29 | 46 | 54 |

STAR LIST

**STA/T STEP** **PROCEDURE** **PANEL** **REMARKS**

## 4.6.5 CHECKLIST REFERENCE CODES (V50 N25)

| R1 Code | ACTION | FUNCTION | REMARKS |
|---|---|---|---|
| 00013 | Perform | Coarse align or pulse torque | |
| 00014 | Perform | Fine align option | |
| 00015 | Perform | Trgt acq | Target (celestial body) acquisition - Used in conjunction with N70, N71 and the following celestial body codes:<br>00 - Planet (any planet except Earth)<br>01 to 45 - Star<br>46 - Sun<br>47 - Earth<br>50 - Moon |
| 00016 | Key in | Term mrk seq | |
| 00041 | Sw | CM/SM sep to up | |
| 00062 | Sw | CMC pwr down | |
| 00202 | Perform | G&N auto mnvr | |
| 00204 | Perform | Enbl gmbl trim option | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|

### 4.6.6 OPTION CODES (V04 N06 or V04 N12)

| R1 Code | Purpose | Input for R2 |
|---|---|---|
| 00001 | Specify IMU orientation | 1 = PREF<br>2 = NOM<br>3 = REFSMMAT<br>4 = Ldg site |
| 00002 | Specify veh | 1 = This veh<br>2 = Other veh |
| 00003 | Specify tracking att | 1 = PREF<br>2 = +X axis |
| 00007 | Specify propul sys | 1 = SPS<br>2 = RCS |

Specified option codes will be flashed in R1 in conjunction with V04 N06 or V04 N12. Requests desired option be loaded into R2.

OPTION CODES (V04 N06 OR V04 N12)

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.6.7 ALARM CODES (V05 N09) | | Alarms for V05 N09<br>(ERR RSET zeros R1 and R2; leaves R3 alone)<br>R1 - first alarm to occur<br>R2 - second alarm to occur<br>R3 - last alarm to occur<br>(There is no indication as to whether 3, or more than 3, alarms have occurred) |
| | Codes starting with 2 signifies POODOO routine: generates software restart (if ave G running, same as BAILOUT; if not, goes to R00). Will not turn on RESTART lt<br>Codes starting with 3 signifies BAILOUT routine: generates software restart (returns to interrupted program). Does not turn on RESTART lt | | The following list shows general numbering logic for alarm codes excluding interfaces and exceptions:<br>00100-00200 Optics subsystem<br>00200-00300 IMU subsystem<br>00400-00600 Rendezvous<br>01100-01200 Computer hardware malfunctions<br>01200-01300 List overflows (all aborts)<br>01300-01400 Interpreter errors<br>01400-01500 Display alarms<br>01500-01600 Keyboard and display programs<br>01600-01700 System test alarms<br>01700-01800 DAP display alarms |
| | 00110 Mrk reject has been entered but ignored (continue) | | Either no marks have been received or there have been no marks since last mark reject. |
| | 00112 Mrk reject with no mrks being acptd (continue) | | |
| | 00113 No inbits (chan 16) (continue) | | If alarm recurs, use MDC DSKY. |
| | 00114 More mrks made than desired (continue) | | |
| | 00115 V41 N91 keyed with OPT MODE not in CMC | | Set OPT MODE - CMC and OPT ZERO - OFF. OPR ERR also lights. |
| | 00116 Opt sw altered before 15 sec zero time elapsed | | Set OPT ZERO - ZERO (≈15 sec to zero). |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 00117 | V41 N91 keyed but CMC has reserved OCDU | | V41 N91 not yet available. May occur from start of drive test until end of burn. |
| 00120 | Opt torque has been req but opt have not been zeroed since last FRESH START or RESTART | | Set OPT ZERO - OFF then ZERO (≈15 sec to zero). |
| 00121 | SC att rates of ≥ two-thirds deg per sec will result in auto reject of sighting mrks | | Repeat mark. |
| 00122 | Marking not called for (continue) | | |
| 00205 | PIPA saturated | | Use SCS control. Refer to G&N malfunction procedures, symptom 12. While thrusting navigation (average G) is operating, a PIPA output in excess of 6399 pulses in a 2-second period has been detected. |
| 00206 | IMU zero routine has been entered with both GMBL LOCK lt and NO ATT lt on | | Coarse align to 0, 0, 0. Reselect V40 N20E. IMU mode switching. |
| 00207 | ISS turn-on req not present for 90 sec | | Redo IMU turn on. Refer to G&N malfunction procedures, symptom 12. |
| 00210 | ISS not on | | Redo IMU turn on. If alarm recurs, perform fresh start (V36E). Consult MSFN. Refer to malfunction procedures, symptom 12. Used by IMU zero routine, R02, P51, and P53. |
| 00211 | Coarse align err | | If P51, 53/P52, 54 in progress, record gyro torquing angles and perform fine align check in P52, 54. Otherwise, refer to V41 N20. Refer to G&N malfunction procedures, symptom 12. Following coarse align, an ICDU is found not to be within 2° of its desired value. |

ALARM CODES (V05 N09)

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 00212 | PIPA fail, but PIPA not being used | | PIPA BIAS check. Refer to G&N malfunction procedures, symptom 6, step 7. A PIPA fail signal has been received by CMC but PIPAs are not being used (average G not on); or CMC has just finished with PIPAs and finds a PIPA fail signal. For latter case, ISS warning light is extinguished. |
| 00213 | IMU not operating with turn-on req | | Refer to 00210. CMC has detected an ISS turn-on request but finds ISS operate not present. |
| 00214 | Prog using IMU when turned off | | Refer to 00210 or exit program. IMU not in use (IMUSE flag reset). IMU in use (IMUSE flag set). |
| 00217 | IMU coarse align or pulse torque difficulty has occurred | | Reinitiate current program. If alarm recurs, terminate use of ISS. Refer to G&N malfunction procedures, symptom 12. This alarm is issued in alignment program, P5X, if coarse align or gyro torquing attempted during IMU turn-on, while a cage command is present or while IMU zeroing is taking place. It is also issued if coarse align failure has occurred (code 211) or if CMC detects ISS warning light on at end of a "successful" coarse alignment or gyro torquing process. |
| 00220 | IMU orient unknown | | Align or if aligned, set REFSMMAT flag. |
| 00401 | Desired middle gmbl angle excessive | | Call N22 - maneuver if MGA <85° or realign IMU. Alarm will be generated if MGA >60° is calculated during:<br>a. Realignment in P52/54<br>b. Entry attitude in P62, P66 display, and P64 (if velocity is <27K FPS at .05 G point). |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 00404 | Trgt out of view (90 deg test) | | P52, P22 and P23. A trunnion angle >90° required to acquire star or landmark. This is a priority alarm and will be displayed by CMC with a flashing V05 N09. |
| | 00405 | Acpt star pair not avail | | In P52 and P54, CMC searches for pair of nav stars which are not <30° and not >76° apart. In addition, neither star may be occulted by earth, sun or moon, and each star must be within 38° of optics shaft axis. If no such pair can be found, alarm is displayed automatically by computer with a flashing V05 N09. |
| | 00406 | Rndz nav not oper | | Select P20 or continue. V54 or V57 has been entered but rendezvous tracking is not operating. CMC ignores request for marks and reinstates interrupted display, if any. |
| | 00421 | W-matrix overflow | | Notify MSFN but continue. W-matrix automatically reinitialized at next mark. |
| | 20430 | Orb integration | | Notify MSFN. Probable state vector uplink required. This may happen if CMC attempts to integrate a state vector that intersects earth or moon. A state vector update may be required. |
| | 00600 | Imaginary roots on 1st iteration | | P32, P72. |
| | 00601 | Post CSI Hp <5.8 NM (85 NM for E.O.) | | P32, P72. |
| | 00602 | Post CDH Hp <5.8 NM (85 NM for E.O.) | | P32, P72. |
| | 00603 | CDH -CSI <10 min | | P32, P72. |
| | 00604 | TPI -CDH <10 min | | P32, P72. |
| | 00605 | No. of iterations exceeds loop max | | P32, P72, P37. |

ALARM CODES (V05 N09)

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 00606 | $\Delta V$ exceeds max | | P32, P72. |
| 20607 | No solution from time $\theta$ or time radius | | Reselect program. Vehicle will be in a hyperbolic orbit, or entry angle too steep. |
| 20610 | Lambda < unity | | Reselect P37 and decrease TIG. Selected GETI yields a radius < entry interface radius. |
| 00611 | No TIG for given ELEV angle | | P33, P34, P73, P74. |
| 00612 | State vctr in wrong sphere of influence | | P37. |
| 00613 | Re-entry angle out of limits | | P37. |
| 00777 | ISS warning caused by PIPA fail | | Refer to G&N malfunction procedures, symptom 6. |
| 01102 | CMC self test err | | Self check. |
| 21103 | Unused CCS branch executed | | Copy N08, notify MSFN. Initiate V36 recovery. CMC has branched to an illogical point in its instruction sequence. |
| 31104 | Delay routine busy | | Reselect extended verb or continue with program. Notify MSFN. An internal routine (DELAYJOB) used by CMC to cause variable time delays, has received requests from more than 4 jobs. |
| 01105 | Downlink too fast | | Rset. If alarm recurs, DOWNLINK FAILURE. Refer to G&N malfunction procedures, symptom 12. |
| 01106 | Uplink too fast | | Rset. If alarm recurs, UPLINK FAILURE. Refer to G&N malfunction procedures, symptom 12. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 01107 | Phase table failure - assume erasable memory is destroyed | | Perform: 1. V74 CMC DOWNLINK<br>2. P27 as necessary<br>3. V48 as necessary (V46)<br>4. Re-establish REFSMMAT via P51 as necessary.<br>If FRESH START recurs, CMC FAILURE. Refer to malfunction procedures, symptom SSR-3. During CMC restart, a phase table disagreement was found. CMC will perform an automatic fresh start if this condition exists. |
| 31201 | Exec overflow - no VAC area | | Reselect extended verb and/or continue program. |
| 31202 | Exec overflow - no core sets | | Refer to 31201. |
| 31203 | Waitlist overflow - too many tasks | | Refer to 31201. |
| 21204 | Neg or zero waitlist call | | If average G on, continue. Otherwise reselect program. |
| 21206 | Second job attempts to go to sleep via keyboard and disp prog | | Refer to 21204. |
| 31207 | No VAC area for marks | | Rset. Reselect program. If alarm recurs, consult MSFN. |
| 21210 | Second attempt is made to stall | | Reselect program. Do not attempt use of device while CMC is using it. While performing certain IMU mode switching functions or while performing automatic attitude maneuvers CMC begins a function or maneuver and then "stalls" until appropriate job has been completed. If a second attempt is made to stall for the same reason (i.e., IMU mode switch or attitude maneuver), this alarm is generated. |

ALARM CODES (V05 N09)

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 31211 | Illegal interrupt of extended verb | | Reselect extended verb after optics marking completed. If an internal request for marks (SXTMARK or R57) made, CMC tests to see if mark system already busy or if an extended verb active. If either condition is discovered, alarm is generated. |
| 01301 | Arcsin or arccos input >1 | | Copy N08, notify MSFN, continue. |
| 21302 | SQRT called with neg argument | | Refer to 21103. |
| 01407 | VG incr | | P40. Refer to G&N malfunction procedures, symptom 12. CMC has determined that last measured value of $\Delta V$ was in such a direction as to cause VG to increase rather than decrease. As long as this condition exists, value of time to go to cutoff is not recalculated (although R1 of N40 will continue to count down) and an automatic engine-off command will not be sent by CMC. |
| 01426 | IMU unsatisfactory | | Realign or use SCS. Neither +Y stable member axis nor -Y stable member axis within 30° of V x R where V and R are present vehicle velocity and position vectors respectively. The test for this condition performed at beginning of P61 and P62. |
| 01427 | IMU reversed | | Note FDAI operation is inverted. The -Y stable member axis is within 30° of V x R (cf. code 1426). |
| 21501 | Keyboard and disp alarm during internal use (NVSUB). | | Refer to 21103. |
| 21502 | Illegal flashing disp | | Refer to 21103. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 01520 | V37 req not permitted at this time | | Wait until COMP ACTY light not on continuously, reselect V37 or if P62/P67, select P00 and then desired program. Alarm will be generated if a V37 request made with IMU as follows:<br>a. In its 90-second turn-on period<br>b. Being caged<br>c. Being zeroed.<br>It will also be generated if V37 request is made for a program other than P00 after entry DAP has been started in P62, during P76 and P00 integration, in P06 and during optics zeroing. |
| 21521 | P01 or P07 illegally sel | | Refer to 21204. |
| 01600 | Overflow in drift test | | This is ground test alarm only. |
| 01601 | Bad IMU torque abort | | Refer to 01600. Generated in P01, P02, or P07. |
| 01602 | Bad opt during verif | | Refer to 01600. This alarm cannot be operated by the CMC. |
| 01703 | Insufficient time for integration | | P40, P41. Will occur between TIG -42.5 and TIG -35 seconds. |
| 03777 | ISS warning caused by ICDU fail | | Refer to G&N malfunction procedures, symptom 6. |
| 04777 | ISS warning caused by ICDU and PIPA fail | | Refer to G&N malfunction procedures, symptom 6. |
| 07777 | ISS warning caused by IMU fail | | Refer to G&N malfunction procedures, symptom 6. |
| 10777 | ISS warning caused by IMU and PIPA fail | | Refer to G&N malfunction procedures, symptom 6. |
| 13777 | ISS warning caused by IMU and ICDU fail | | Refer to G&N malfunction procedures, symptom 6. |
| 14777 | ISS warning caused by IMU, ICDU, and PIPA fail | | Refer to G&N malfunction procedures, symptom 6. |

ALARM CODES (V05 N09)

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|

## 4.6.8 CMC PROGRAM - ROUTINE INDEX

### 4.6.8.1 Programs

| Phase | Program No. | Program Title | Contains Crew Interface Routines |
|---|---|---|---|
| Pre-Launch & Service | 00 | CMC idling | None |
| | 01 | Prelaunch or service init | None |
| | 02 | Prelaunch or service gyro compassing | None |
| | 03 | Prelaunch or service opt verif of gyro compassing | None |
| | 06 | CMC pwr down | R00 |
| | 07 | Sys test | |
| Boost | 11 | Earth orb insertion mon | None |
| | 15 | CMC TB6 init | R00 |
| Coast | 20 | Rndz nav | R02,R61,R52,<br>R00,R22,R21 |
| | 21 | Grd track determ | R00 |
| | 22 | Orb nav | R02,R53,R52,<br>R00 |
| | 23 | Cislunar midcourse nav | R00,R53,R52 |
| | 24 | Rate aided opt | R00,R53,R52 |
| | 27 | CMC update | None |

Do not select the following program sequences:

a. P3X - P7X - P40/P41
P3X - P23 - P40/P41
(P3X computations are overwritten)
Redo P3X and then P40 or P41

b. P40/P41 - P27 - P52
(P27 overwrites preferred attitude computations)
Redo P40/P41 up to V50 N18, then reselect P52

c. P27 - P40/P41 - 52
Reload preferred REFSMMAT from ground.

| STA/T STEP | | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| Phase | Program No. | Program Title | Contains Crew Interface Routines | |
| Pre-Thrusting | 30 | External $\Delta V$ | R00 | |
| | 32 | Co-elliptic seq init (CSI) | R00 | |
| | 33 | Constant $\Delta$alt (CDH) | R00 | |
| | 34 | Trnfr phase init (TPI) | R00,R22,R21 | |
| | 35 | Trnfr phase (midcourse) | R00,R22,R21 | |
| | 37 | Ret to Earth | R00 | |
| Thrusting | 40 | SPS | R02,R60,R00 | |
| | 41 | RCS | R02,R60,R00 | |
| | 47 | Thrust mon | R02,R00 | |
| Alignment | 51 | IMU orient determ | R53,R54,R00 | |
| | 52 | IMU realign | R02,R50,R00 R52, R53, R54, R55 | |
| | 53 | Back-up IMU orient determ | R56, R54, R00 | |
| | 54 | Back-up IMU realign | R02, R50, R00 R56, R54, R55 | |
| Entry | 61 | Entry prep | R02 | |
| | 62 | CM/SM sep and pre-entry mnvr | R02 | |
| | 63 | Entry init | None | |
| | 64 | Post 0.05 G | None | |

CMC PROGRAM - ROUTINE INDEX

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|

| Phase | Program No. | Program Title | Contains Crew Interface Routines |
|---|---|---|---|
| | 65 | Entry upcontrol | None |
| | 66 | Ballistic entry | None |
| | 67 | Fnl phase | R00 |
| Abort | 72 | LM co-elliptic seq trgtg (CSI) | R00 |
| | 73 | LM constant Δalt trgtg (CDH) | R00 |
| | 74 | LM trnfr phase init (TPI) trgtg | R22,R00,R21 |
| | 75 | LM trnfr phase (midcourse) trgtg | R22,R00,R21 |
| | 76 | Trgt ΔV | R00 |

### 4.6.8.2 Routines

| Routine | Routine Title | Remarks |
|---|---|---|
| 00 | Fnl auto req term | |
| 02 | IMU stat check | |
| 03 | DAP data load | Manually selected by crew (V48E). |
| 05 | S bd ant | Manually selected by crew (V64E). |
| 21 | Rndz tracking sighting mrk | Manually selected by crew (V57E). |
| 22 | Rndz tracking data processing | |
| 23 | Backup rndz tracking sighting mrk | Manually selected by crew (V54E). |
| 30 | Orb param disp | May be called by crew (V82E). |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| Routine | Routine Title | | |
| 31 | Rndz param disp routine No. 1 | | Displays range, range rate, and the angle between CSM +X axis and local horizontal (theta). Selected by crew (V83E). |
| 33 | CMC/LGC clock sync | | V06 N65. |
| 34 | Rndz param disp routine No. 2 | | Displays range, range rate, and angle between optics star line of sight and local horizontal (phi). Selected by crew (V85E). |
| 36 | Rndz out of plane disp | | Selected by V90E. |
| 40 | SPS thrust fail | | |
| 41 | State vctr integration (mid to ave) | | |
| 50 | Coarse align | | |
| 52 | Auto opt positioning | | Automatically selected by P20, P22, P23 or P52. It is self-perpetuating and terminated by R53 for star or landmark sightings. |
| 53 | Sighting mrk | | |
| 54 | Sighting data disp | | |
| 55 | Gyro torquing | | |
| 56 | Alternate LOS sighting mrk | | Used to perform sighting marks for backup alignment programs P53 and P54. |
| 57 | Opt calib | | |
| 60 | Att mnvr | | |
| 61 | Tracking att | | Orients CSM properly with respect to target vehicle during rendezvous tracking. |
| 62 | Crew defined mnvr | | Selected by (V49E) via P00 only. |
| 63 | Rndz fnl att | | Selected by (V89E) via P00 only. |
| 64 | Orbrate/PTC (BBQ mode - R64) | | Selected by (V79E). |

CMC PROGRAM - ROUTINE INDEX

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|

## 4.6.9 CMC PROGRAM - FLAG LISTING

The flags which are applicable to colossus programs are summarized in this section for information purposes only. Paragraph 4.6.9.1 shows the correlation between flag word numbers and erasable memory addresses while paragraph 4.6.9.2 lists the relationship between flags and programs.

### 4.6.9.1 Flag Word - Memory Location Correlation

| Flag Word | Memory Address |
|---|---|
| 0 | 00074 |
| 1 | 00075 |
| 2 | 00076 |
| 3 | 00077 |
| 4 | 00100 |
| 5 | 00101 |
| 6 | 00102 |
| 7 | 00103 |
| 8 | 00104 |
| 9 | 00105 |
| 10 | 00106 |
| 11 | 00107 |

### 4.6.9.2 Flag - Program Listing

| No. | Title | Code | Flag Word | Bit | When Set | When Reset |
|---|---|---|---|---|---|---|
| FLAGS | | | | | | |
| 1 | Rndz | RNDVZFLG | 0 | 7 | P20 init | P20 term |
| 2 | Update | UPDATFLG | 1 | 7 | State vctr up-dating by marks allowed | State vctr up-dating by marks not allowed |
| 3 | Track | TRACKFLG | 1 | 5 | Rndz tracking allowed | Rndz tracking not allowed |
| 4 | Pref att | PFRATFLG | 2 | 4 | Preferred SC att computed | Preferred SC att not computed |
| 5 | Steer | STEERSW | 2 | 11 | Steering to be done | Steering omitted |
| 6 | IMU orient | REFSMFLG | 3 | 13 | REFSMMAT good | REFSMMAT not good |
| 7 | IMU | IMUSE | 0 | 8 | IMU in use | IMU not in use |
| 8 | State vctr | VEHUPFLG | 1 | 8 | CSM state vctr updated | LM state vctr updated |
| 9 | Term | TERMIFLG | 7 | 15 | Term R52 and R53 | Do not term |
| 11 | Trgt 1 | TARG1FLG | 1 | 10 | Sighting LM | Not sighting LM |
| 12 | Trgt 2 | TARG2FLG | 1 | 9 | Sighting lmk | Sighting Star |
| 13 | W matrix (rndz | RENDWFLG | 5 | 1 | W matrix for rndz nav valid | W matrix for rndz nav invalid |
| 14 | W matrix (orb nav) | ORBWFLAG | 3 | 6 | W matrix for orb nav valid | W matrix for orb nav invalid |

CMC PROGRAM - FLAG LISTING

| No. | Title | Code | Flag Word | Bit | When Set | When Reset |
|---|---|---|---|---|---|---|
| 15 | 3 axis | 3AXISFLG | 5 | 6 | Mnvr specified by 3 axes | Mnvr specified by 1 axis |
| 16 | External ΔV | XDELVFLG | 2 | 8 | External ΔV VG computations | Lambert VG computations |
| 17 | Active veh | AVFLAG | 2 | 5 | LM active | CSM active |
| 18 | Final comp | FINALFLG | 2 | 6 | Fnl pass thru rndz prog comp | Interim pass thru rndz prog comp |
| 19 | Sighting mrk | R53FLAG | 0 | 6 | V51 initiated | V51 not initiated |
| 20 | Stick flag | STIKFLAG | 1 | 14 | RHC out of detent (auto mnvr not enabled) | RHC in detent (auto mnvr enabled) |
| 21 | Surface | SURFFLAG | 8 | 8 | LM on lunar surface | LM not on lunar surface |
| 22 | LM sphere | LMOONFLG | 8 | 11 | Permanent LM state in lunar sphere | Permanent LM state in earth sphere |
| 23 | CM sphere | CMOONFLG | 8 | 12 | Permanent CSM state in lunar sphere | Permanent CSM state in earth sphere |
| NON-FLAGS | | | | | | |
| 1 | Mrk | MARKSTAT | 1344* | 10 | After sighting mark | After mark reject |
| 2 | ISS zero | IMODES30 | 1334* | 9 | IMU opr bit present (set to 0) | IMU opr bit not present (reset to 1) |

*Memory address

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|

## 4.7 G&C REFERENCE MODES

This section provides information about basic G&C functions by defining them in terms of system operating prerequisites and switch positions which together represent reference modes. Their scope is limited to independent system functions. These reference modes are repeatable and are applicable to all G&C procedures and thus are referenced in all subsequent sections of G&C procedures. The modes, however, are NOT intended to be complete or self-contained procedures.

Wherever a step in one of these G&C reference modes references another mode, the title and paragraph number of the referenced mode is shown and the recommended options in the mode, if any, are specified. Only those switches which are required to be in unique positions are shown in the affected step after the mode is referenced.

During time-critical mission phases, reference to other sections of the handbook cannot be accommodated, and, therefore, all time-critical operations are self-contained. Modes similar to those shown in this section, however, are contained or repeated within the time-critical procedures.

For general G&C operating data, refer to operating notes, 4.6.1.

### 4.7.1 ATTITUDE CONTROL

#### 4.7.1.1 SCS Channel Selection

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | | | Provides methods for enabling RCS auto coils without undesirable jet firings. |
| | 1 | Set pwr sw | | |
| CDR | | LOGIC 2/3 PWR - on (up) | 7 | Supplies 28 vdc to SC CONT switch, THC CW switch and ATT 1/RATE 2 and RATE 2 positions of BMAG MODE switches. |
| | | SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | | 4.6.1.2, note 5. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 2 | Enable auto coils | | |
| | | For CMC cont | | |
| CDR | | SC CONT - CMC<br>CMC MODE - FREE | 1 | For post CM/SM separation, AUTO RCS A/C ROLL switches should be OFF, and DAP configured for B/D roll. Also refer to 4.6.1.1, note 7. |
| | | MAN ATT (3) - MIN IMP or RATE CMD | | 4.6.1.1, note 8. |
| | | AUTO RCS (16) - MNA or MNB or OFF (correspond to RCS DAP configuration) | 8 | Configure AUTO RCS roll enable to agree with RCS DAP load, to reduce SPS propellant slosh during ΔV thrusting in the event of a failed-on roll jet. |
| | | For SCS cont | | |
| | | a. SC CONT - SCS | 1 | |
| | | or SC CONT - CMC<br>THC - CW | | |
| | | b. BMAG MODE (3) - RATE 2 | | BMAG MODE or MAN ATT switching cages BMAGs and prevents attitude error signals from causing jet firings. |
| | | or MAN ATT (3) - MIN IMP or ACCEL CMD | | |
| | | c. AUTO RCS (16) - MNA or MNB | 8 | For SCS control, switches should be set by quad and rotation axis, as desired. Only one roll quad should be enabled for SCS control to optimize RCS propellant consumption. One exception is 3-axis translation when all quads are required. |
| | 4.7.1.2 | SCS Minimum Impulse | | |
| | 1 | Set pwr sw<br>ELEC PWR - GDC/ECA or ECA | 7 | Either position required for minimum impulse generator. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | LOGIC 2/3 PWR - on (up)<br>SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | 7 | Supplies 28 vdc to SC CONT switch, and THC CW switch. 4.6.1.2, note 5. |
| | | RHC PWR NORM (both) - AC/DC | 1 | |
| | 2 | Sel min imp cont<br>MAN ATT - MIN IMP<br>SC CONT - SCS | | Switches should be set by axis as desired. |
| or | | SC CONT - CMC<br>THC - CW | | |
| | 3 | Enable auto coils, 4.7.1.1 | | |
| | 4.7.1.3 | SCS Acceleration Command | | |
| | 1 | Set pwr sw<br>LOGIC 2/3 PWR - on (up)<br>SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | 7 | Supplies 28 vdc to SC CONT switch. 4.6.1.2, note 5. |
| | | RHC PWR NORM (both) - AC/DC | 1 | |
| | 2 | Sel accel cmd cont<br>MAN ATT - ACCEL CMD | | Switches should be set by axis as desired. |
| | 3 | Enable auto coils, 4.7.1.1 | | Either CMC or SCS control permissible. |
| | 4.7.1.4 | SCS Attitude Hold/Rate Command | | |
| | 1 | Set pwr sw<br>LOGIC 2/3 PWR - on (up)<br>ELEC PWR - GDC/ECA or ECA | 7 | Supplies 28 vdc to SC CONT switch. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | SIG CONDR/DR BIAS PWR 1 - AC1 or AC2 | 7 | Provides SCS signal conditioner power for RHC proportional rate command TLM. Also refer to 4.6.1.2, note 5. |
| | BMAG PWR (both) - ON | | If rate damping only is desired, BMAG 1 need not be turned ON but should be set to WARMUP. |
| | RHC PWR NORM (1, 2 or BOTH) - AC/DC | 1 | If manual override of attitude hold desired. |
| 2 | Enable auto coils, 4.7.1.1 | | 4.6.1.1, note 7. |
| 3 | Establish att hold<br>MAN ATT - RATE CMD<br>SC CONT - SCS<br>or SC CONT - CMC<br>THC - CW<br>BMAG MODE - ATT 1/RATE 2 | | Switches may be set by axis as desired. Also refer to 4.6.1.2, note 6. |
| | 4.7.1.5 CMC Minimum Impulse | | |
| 1 | The following are req<br>CMC - on, 4.8.1.3<br>RCS DAP - load & activate, 4.8.2.1 | | CMC, ISS, and RCS DAP enable autopilot control. Minimum impulse controller (MIC), located on panel 122 in LEB, and RHC provides minimum impulse command capability in this mode. RHC will provide normal acceleration commands providing MAN ATT switches at ACCEL CMD. |
| | ISS - on (desired), 4.8.1.3 | | For display of ISS total attitude and errors. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 2 | Set pwr sw | | |
| CDR | | LOGIC 2/3 PWR - on (up) | 7 | Supplies 28 vdc to SC CONT switch. |
| | | SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | | 4.6.1.2, note 5. |
| | | RHC PWR NORM (both) - AC/DC | 1 | |
| | 3 | Establish CMC Cont | | |
| | | SC CONT - CMC | | |
| | | CMC MODE - FREE | | |
| | | MAN ATT (3) - MIN IMP | | ACCEL CMD position cannot be used because it inhibits CMC outputs to jets. |
| | or | MAN ATT (3) - RATE CMD | | |
| | | BMAG MODE (3) - RATE 2 | | |
| | 4 | Enable Auto Coils, 4.7.1.1 | | |
| | 4.7.1.6 | CMC Attitude Control - Auto/Hold | | |
| | 1 | The following are req | | CMC, ISS, and RCS DAP enable autopilot control. |
| | | CMC - on, 4.8.1.3 | | |
| | | ISS - on, 4.8.1.3 | | |
| | | RCS DAP - load & activate, 4.8.2.1 | | |
| | 2 | Set pwr sw | | |
| | | LOGIC 2/3 PWR - on (up) | 7 | Supplies 28 vdc to SC CONT switch. |
| | | SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | | 4.6.1.2, note 5. |
| | 3 | Enable auto coils, 4.7.1.1 | | |
| | 4 | Establish att cont | | |
| | | MAN ATT (3) - RATE CMD or MIN IMP | 1 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | SC CONT - CMC | 1 | |
| | | CMC MODE - HOLD or AUTO | | AUTO position must be selected when CMC automatic maneuver desired. |
| | | 4.7.1.7 SIVB Attitude Control | | Describes condition required to enable RHC rate control of SIVB. |
| | 1 | The following are req | | |
| | | CMC - on, 4.8.1.3 | | |
| | | LOGIC 2/3 PWR - on (up) | 7 | Supplies power for caging BMAGs via BMAG MODE switches. |
| | | ISS - on (desired), 4.8.1.3 | | For display of ISS total attitude and errors. |
| | 2 | Enable att cont | | |
| CMP | | Saturn DAP activated, 4.8.2.1 | 2,140 | Load 3 in configuration option of DAP activation procedure. Also refer to 4.6.1.1, note 7. AUTO RCS switches should be off to prevent SM jet firing. |
| | | LV GUID sw - CMC | 2 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.7.2 | ATTITUDE DISPLAYS | | |
| | 4.7.2.1 | Rate Display | | Provides methods for displaying rate information on rate needles of FDAI 1 or FDAI 2, or both, as desired. |
| | 1 | Set pwr sw | | |
| CDR | | FDAI/GPI PWR - 1, 2 or BOTH | 7 | Provides power for display electronics. Position chosen depends on which FDAI(s) desired. |
| | | LOGIC 2/3 PWR - on (up) | | 4.6.1.1, note 6. |
| | | BMAG 2 PWR - ON<br>(req if BMAG 2 desired)<br>BMAG 1 PWR - ON<br>(req if BMAG 1 desired) | | Either BMAG 1 or BMAG 2 may be selected to provide information. BMAG 2 is normally used and BMAG 1 provides backup capability. |
| | 2 | Sel desired rate source | | Switches should be set by axis as desired. |
| | | BMAG MODE - RATE 2 or ATT 1/RATE 2 | 1 | Selects BMAG 2. |
| | or | BMAG MODE - RATE 1 | | Selects BMAG 1. |
| | 3 | Sel disp configuration | | |
| | | FDAI SEL - 1 | | Displays rate from BMAG 1 or 2 on FDAI 1 only. |
| | or | FDAI SEL - 2 | | Displays rate from BMAG 1 or 2 on FDAI 2 only. |
| | or | FDAI SEL - 1/2 | | Displays rate from BMAG 1 or 2 on both FDAIs. |
| | 4.7.2.2 | Attitude Error Display - BMAG Source | | Provides methods for displaying BMAG 1 attitude error information on attitude error needles of FDAI 1 or FDAI 2. Needles display attitude excursion from point at which BMAGs are uncaged up to a maximum of 17°. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 1 | Set pwr sw | | |
| CDR | | FDAI/GPI PWR - 1, 2 or BOTH | 7 | Provides power for display electronics. Position chosen depends on which FDAI(s) desired. |
| | | LOGIC 2/3 PWR - on (up) | | Supplies power for caging BMAGs via BMAG MODE switches. |
| | | BMAG 1 PWR - ON | | Powers BMAGs in gyro assembly 1, the only BMAGs capable of providing attitude error information. |
| | 2 | Provide att err info<br>MAN ATT - RATE CMD | 1 | Switches should be set by axis as desired. RATE CMD position required to uncage BMAG 1. However, RHC breakout and MAN ATT switches overridden by IGN 2 logic signal during thrusting to uncage BMAGs. |
| | | BMAG MODE - ATT 1/RATE 2<br>RHC - neut | | If RHC breakout switches activated, BMAGs caged (by axis) and attitude hold lost. |
| | 3 | Sel disp configuration | | |
| | | a. FDAI SEL - 1/2 | | Displays attitude error from BMAG 1 on FDAI 2. |
| | or | b. FDAI SEL - 1 or 2<br>FDAI SOURCE - GDC | | Displays attitude error from BMAG 1 on FDAI 1 or 2. This position required when only one FDAI selected. |
| | 4.7.2.3 | Attitude Error Display - CMC Source | | Provides G&N computed attitude error in control axes. Information meaningful only when computer program defines desired attitude. |
| | 1 | The following are req<br>CMC - on, 4.8.1.3<br>ISS - on, 4.8.1.3 | | <br>Required to compute error and mode CDUs.<br>Required for attitude information. |
| | 2 | Set pwr sw<br>FDAI/GPI PWR - 1, 2 or BOTH | 7 | Provides power for display electronics. Position chosen depends on which FDAI(s) desired. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | LOGIC 2/3 PWR - on (up) | 7 | Provides power for FDAI switches. |
| | 3 | Select disp scaling<br>FDAI SCALE - 5/5 or 5/1 | 1 | Positions provide for compatible scaling between CMC and display electronics in roll axis during orbital flight. If 50/15, 50/10 position is chosen, roll scaling is 12.5° full scale. |
| | 4 | Sel disp configuration | | |
| | | a. FDAI SEL - 1/2 | | Displays attitude error from CDUs on FDAI 1. |
| | or | b. FDAI SEL - 1 or 2<br>FDAI SOURCE - CMC | | Displays attitude error from CDUs on FDAI 1 or 2. This position required when only one FDAI selected. |
| | 4.7.2.4 | Attitude Error Display - Attitude Set Source | | Provides methods for displaying attitude difference between attitude set indicators and GDC (body error) or IMU gimbal angles (Euler error). Polarity reversal occurs when ATT SET - IMU option selected and roll gimbal angle >±90°. Pitch and yaw attitude error needles become "fly from" indicators rather than "fly to" indicators in this instance. |
| | 1 | Set pwr sw & disp logic<br>FDAI/GPI PWR - 1, 2 or BOTH | 7 | Provides power for display electronics. Position depends on which FDAI desired. |
| | | LOGIC 2/3 PWR - on (up) | | |
| | | FDAI SEL - 1 or 2 | 1 | Display not available at 1/2 position. |
| | | FDAI SOURCE - ATT SET | | Required to enable attitude set input to FDAI. |
| | 2 | Sel att ref | | |
| | | a. SCS<br>ELEC PWR - GDC/ECA | 7 | Provides power to GDC electronics. |
| | | BMAG 2 PWR - ON | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | ATT SET - GDC | 1 | |
| | BMAG MODE - RATE 2 or ATT 1/RATE 2 | | Switches should be set by axis as desired. |
| | b. ISS | | |
| | ISS - on, 4.8.1.3 | | 4.6.1.1, note 5. |
| | ATT SET - IMU | | |
| 4.7.2.5 | Total Attitude | | Provides methods for displaying Euler angles on FDAI ball from GDC or IMU. |
| 1 | Set pwr sw & enable FDAI | | |
| | FDAI/GPI PWR - 1, 2 or BOTH | 7 | Provides power for display electronics. Position depends on which FDAI(s) desired. |
| | LOGIC 2/3 PWR - on (up) | | Supplies power for FDAI, BMAG MODE switches and ATT SET switch (IMU position). |
| 2 | Sel disp & disp source | | |
| | a. ISS disp | | |
| | ISS - on, 4.8.1.3 | | |
| | FDAI 1 disp | | Enables IMU resolver outputs to FDAI 1 ball drive. There are three possible switch combinations. |
| | FDAI SEL - 1/2 | 1 | This position also enables GDC total attitude to FDAI No. 2. |
| | or FDAI SEL - 1 | | |
| | FDAI SOURCE - CMC | | |
| | or FDAI SOURCE - ATT SET | | 4.6.1.1, note 5. |
| | ATT SET - IMU | | |
| | FDAI 2 disp | | Enables IMU resolver outputs to FDAI 2 ball drive. There are two possible switch combinations. |
| | FDAI SEL - 2 | | |
| | FDAI SOURCE - CMC | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | or FDAI SOURCE - ATT SET<br>ATT SET - IMU | 1 | 4.6.1.1, note 5. |
| | b. GDC disp | | |
| | ELEC PWR - GDC/ECA | 7 | Provides power to GDC electronics. |
| | BMAG 2 PWR - ON | | |
| | BMAG MODE - RATE 2 or ATT 1/RATE 2 | 1 | Switches should be set by axis as desired. |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | BMAG 1 PWR - ON (if BMAG 2 fails) | 7 | |
| | BMAG MODE - RATE 1 | 1 | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | FDAI 2 disp<br>FDAI SEL - 1/2 | | Enables GDC resolver outputs to FDAI 2 ball drive. There are three possible switch combinations. |
| | or FDAI SEL - 2<br>FDAI SOURCE - GDC | | |
| | or FDAI SOURCE - ATT SET<br>ATT SET - GDC | | |
| | FDAI 1 disp<br>FDAI SEL - 1<br>FDAI SOURCE - GDC | | Enables GDC resolver outputs to FDAI 1 ball drive. There are two possible switch combinations. |
| | or FDAI SOURCE - ATT SET<br>ATT SET - GDC | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.7.2.6 ORDEAL - Local Horizontal Attitude | | Provides methods for displaying local horizontal reference established by ORDEAL on FDAI 1 and/or FDAI 2 balls. Only pitch axis is affected. |
| 1 | Set pwr sw | | |
| | FDAI/GPI PWR - 1, 2 or BOTH | 7 | Provides power for display electronics.<br>Position chosen depends on which FDAI(s) desired. |
| | EARTH/LUNAR - EARTH or LUNAR | 13 | |
| | LTG - BRT or DIM | | |
| 2 | Sel disp configuration | | Reference system may be GDC or IMU, 4.7.2.5. |
| | FDAI 1 disp | | |
| | FDAI SEL - 1 or 1/2 | 1 | |
| | FDAI 1 sw - ORB RATE | 13 | |
| | FDAI 2 disp | | |
| | FDAI SEL - 2 or 1/2 | 1 | |
| | FDAI 2 sw - ORB RATE | 13 | |
| | FDAI 1 & 2 disp | | |
| | FDAI SEL - 1/2 | 1 | |
| | FDAI sw (both) - ORB RATE | 13 | |
| | 4.7.3 GDC ALIGN | | Aligns GDC to ATT SET thumbwheels. |
| | ELEC PWR - GDC/ECA | 7 | Supplies power to GDC electronics. |
| | ATT SET - GDC | 1 | Enables att set inputs to GDC. |
| | Verify tw settings | | |
| | GDC ALIGN pb - push | | Enables attitude set inputs to GDC and disables BMAG inputs. |

GDC ALIGN

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.7.4 SPS THRUST CONTROL | | |
| | 4.7.4.1 TVC Initialization | | Defines safe switch configuration required before initiation of thrusting procedures. |
| CDR | LOGIC 2/3 PWR - on (up) | 7 | Provides power to SCS TVC switches. |
| | SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | | Required for RCS jet on-off and MTVC TLM. |
| | SPS THRUST - NORM | 1 | |
| | SCS TVC (2) - RATE CMD (if burn is G&N or MTVC) | | |
| or | SCS TVC (2) - AUTO (SCS burn) | | |
| | TVC GMBL DR (2) - AUTO | | The 1 or 2 positions may be used as backup if required. |
| | ΔV CG - LM/CSM or CSM | | Required only for SCS/SPS auto thrusting. Position depends on whether LM attached or not. |
| | FDAI/GPI PWR - 1, 2 or BOTH | 7 | Position chosen depends on whether redundant GPI displays desired. To enable redundant GPI indicators, FDAI/GPI PWR switch must be set to BOTH. |
| | LV IND/GPI sw - GPI | 1 | |
| | 4.7.4.2 SPS Gimbal Control | | |
| 1 | CMC Cont | | |
| | ISS - on (req), 4.8.1.3 | | Provides attitude information and power to ECDUs. |
| | CMC - on (req), 4.8.1.3 | | |
| | Servo loop activated (step 4) | | |
| | Gmbl mot on | | Operating time limited depending on operating conditions. MN BUS TIE (2) must be on before gimbal motors started. |
| | SC CONT - CMC | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | LOGIC 2/3 PWR - on (up) | 7 | Supplies power to SC CONT switch. |
| | | THC - neutral | | |
| | 2 | SCS Cont - AUTO | 1 | |
| | | Servo loop activated (step 4) | | |
| | | Gmbl mot on | | Operating time limited depending on operating conditions. MN BUS TIE (2) must be on before gimbal motors are started. |
| | | LOGIC 2/3 PWR - on (up) | 7 | Supplies power to SC CONT, BMAG MODE, SCS TVC, .05 G switch (OFF position) and THC CW switches. |
| | | ELEC PWR - ECA or GDC/ECA | | Supplies power to the control electronics. |
| | | BMAG PWR (both) - ON | | Rate and attitude sensors required. |
| | | BMAG MODE - ATT 1/RATE 2 | 1 | BMAGs in gyro assembly 1 will uncage if MAN ATT switches are at RATE CMD. If not, uncaging will occur when IGN 2 logic signal is present. |
| | | SCS TVC (2) - AUTO | | |
| | | IGN 2 logic sig present | | Provided by thrust control logic at engine on until 1 second after engine off. |
| | | SC CONT - SCS | | |
| | | THC - neut | | |
| | or | SC CONT - CMC | | |
| | | THC - CW | | |
| | 3 | MTVC cont - RATE CMD/ACCEL CMD | | Stick integrator is enabled when IGN 2 logic signal is present. IGN 2 logic signal present at SPS on until 1 second after SPS - off, is provided by thrust control electronics. |

SPS THRUST CONTROL

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | Servo loop activated (step 4) | | |
| | Gmbl mot on | | Operating time limited depending on operating conditions. MN BUS TIE (2) must be on before gimbal motors started. |
| | LOGIC 2/3 PWR - on (up) | 7 | Provides power for SC CONT, BMAG MODE, SCS TVC and THC - CW switches. |
| | SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | | Required for RCS jet on-off and MTVC TLM. |
| | ELEC PWR - ECA or GDC/ECA | | Supplies power to RHCs and control electronics. |
| | BMAG 2 PWR - ON (for RATE CMD) | | Rate information required for RATE CMD MTVC. |
| | BMAG MODE (3) - ATT 1/RATE 2 or RATE 2 | 1 | |
| | RHC PWR NORM (both) - AC/DC | | |
| | Rate Cmd | | |
| | a. SCS TVC (2) - AUTO<br>SC CONT - SCS<br>THC - CW | | |
| or | b. SCS TVC (2) - RATE CMD<br>SC CONT - SCS | | |
| | or SC CONT - CMC<br>THC - CW | | |
| | Accel Cmd | | |
| | a. SCS TVC (2) - ACCEL CMD<br>SC CONT - SCS | | |
| | or SC CONT - CMC<br>THC - CW | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4 | Servo Loop Activation | | |
| | a. | Servo loop No. 1 | | |
| CDR | | TVC SERVO PWR 1 - AC1/MNA | 7 | Provides power to clutches and servo drive electronics. Alternate position of this switch (AC2/MNB) should be used only in the event of an AC1 bus failure to provide additional redundancy. AC1/MNA position should be used in all other cases to be compatible with d-c power source for gimbal motors (DC MNA bus power). |
| | | TVC GMBL DR (2) - 1 | 1 | |
| | | or TVC GMBL DR (2) - AUTO<br>THC - neut<br>GMBL MOT 1 - operating | | No. 1 gimbal motor must be on with no overcurrent failure sensed. |
| | | or TVC SERVO PWR 2 - OFF | 7 | |
| | b. | Servo loop No. 2 | | |
| | | TVC SERVO PWR 2 - AC2/MNB | | Alternate position of this switch (AC1/MNA) should be used only in the event of an AC2 bus failure to provide additional redundancy. AC2/MNB position should be used in all other cases to be compatible with d-c power source for gimbal motors (DC MNB bus power). |
| | | TVC GMBL DR (2) - 2 | 1 | |
| | | or TVC GMBL DR (2) - AUTO<br>LOGIC 2/3 PWR - on (up)<br>THC - CW | 7 | Provides power to THC - CW switch. |
| | | or TVC GMBL DR (2) - AUTO<br>GMBL MOT 1 - not operating | 1 | If No. 1 gimbal motor is off or an overcurrent sensed, control transferred to No. 2 servo loop. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.7.4.3 Thrust On-Off Control | | |
| 1 | CMC Cont | | |
| | ISS - on (req), 4.8.1.3 | | |
| | CMC - on (req), 4.8.1.3 | | |
| | SPS Gmbl Cont (desired), 4.7.4.2 | | |
| | SC CONT - CMC | | To satisfy CMC control, THC must not be CW. |
| | LOGIC 2/3 PWR - on (up) | 7 | Supplies 28 vdc to SC CONT switch. |
| | SPS THRUST - NORM | 1 | DIR ON will override CMC thrust-on control. |
| | ΔV THRUST A(B) - NORM | | Guarded. |
| | Thrust on | | |
| | CMC eng on cmd (P40) | | |
| | Thrust off | | |
| | CMC eng off cmd (P40) | | |
| | or ΔV THRUST A &/or B - OFF | | Guarded. |
| 2 | SCS Cont | | |
| | SPS Gmbl Cont (desired), 4.7.4.2 | | |
| | SC CONT - SCS | | |
| | or SC CONT - CMC | | This option may establish SCS MTVC mode depending on position of SCS TVC switches. |
| | THC - CW | | |
| | LOGIC 2/3 PWR - on (up) | 7 | Supplies 28 vdc to SC CONT switch. |
| | SPS THRUST - NORM | 1 | DIR ON will override SPS thrust control. |
| | ΔV THRUST A(B) - NORM | | Guarded. |
| | Thrust on | | |
| | ΔV ind - not zero | | Required only if EMS FUNC in ΔV or ΔV TEST. |
| | THC - +X | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | or DIR ULL pb - push | 1 | |
| | | THRUST ON pb - push | | |
| | | Thrust off<br>EMS FUNC - ΔV<br>ΔV ind - zero | | |
| | | or ΔV THRUST A &/or B - OFF | | Guarded. |
| | 3 | Dir Cont<br>SPS Gmbl Cont (desired), 4.7.4.2 | | |
| | | Thrust on<br>ΔV THRUST A &/or B - NORM | | Guarded. |
| | | SPS THRUST - DIR ON | | Lever lock. |
| | | Thrust off<br>ΔV THRUST A &/or B - OFF | | Guarded. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.7.5 OPTICS CONTROL | | |
| | | 4.7.5.1 Auto Optics Positioning | | This procedure permits CMC control of optics. |
| | 1 | The following are req<br>ISS - on, & orient known, 4.8.1.3 & 4.14<br>CMC - on, 4.8.1.3<br>Opt - on, 4.8.1.4 | | |
| | 2 | Establish CMC cont | | |
| CMP | | OPT ZERO - OFF | 122 | |
| | | OPT TELTRUN - SLAVE TO SXT | | Required for SCT trunnion drive. |
| | | OPT MODE - CMC | | |
| | | 4.7.5.2 Manual Optics Control | | Permits manual control of optics using optics hand control (OHC). |
| | 1 | Opt - on, 4.8.1.4 | | |
| | 2 | Establish man cont & sighting options | | |
| | | OPT ZERO - OFF | | |
| | | OPT COUPLING - DIR or RSLV | | Permits desired image motion in FOV. In DIRECT mode, OHC left, right motion drives optics shaft, while up, down motion drives trunnion. RSLV mode provides motion resolved into SC body coordinates. Motion appears to be target motion corresponding to direction of OHC movement. |
| | | OPT MODE - MAN | | |
| | | OPT TELTRUN - SLAVE TO SXT | | Required for proper landmark tracking. |
| | or | 0° | | Provides zeroing of SCT trunnion axis. |
| | or | 25° | | Provides greater scanning capability for star sightings. |
| | | OPT SPEED - HI, MED or LO | | Set as desired. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.7.5.3 Manual Optics Drive | | Permits manual optics operation (no power) using optics tool. |
| | 1 | The following are req | | |
| LMP | | G/N PWR - AC1 or AC2 | 5 | Supplies power for condition lamps and reticle. |
| CMP | | G/N OPT PWR - OFF | 100 | |
| | 2 | Obtain opt tool from tool kit | | |
| | 3 | Perform man opt drive | | |
| | | RETCL BRT tw - as req | 122 | |
| | | SHAFT - as desired | 121 | |
| | | TRUN - as desired | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.7.6 | ENTRY MONITOR SYSTEM (EMS) | | |
| | 4.7.6.1 | ΔV Test & Null Bias Check | | |
| | 1 | Init EMS prep | | |
| CDR | | EMS FUNC - OFF (verify) | 1 | |
| | | cb EMS (2) - close | 8 | |
| | | EMS MODE - STBY | 1 | |
| | 2 | EMS FUNC - ΔV SET | | Enables slewing of ΔV indicator. |
| | | Adj alphanumeric brightness (option) | | |
| | | EMS MODE - NORM | | 4.6.1.1, note 9. |
| | | Set ΔV ind to +1586.8 fps | | |
| | 3 | EMS FUNC - ΔV TEST | | ΔV TEST checks ΔV circuitry. |
| | | SPS THRUST lt - on | | |
| | | ΔV ind decr (10 sec) | | |
| | | SPS THRUST lt - out ≈-0.1 fps on ΔV ind | | |
| | | ΔV ind stops at -20.8±20.7 fps | | |
| | 4 | EMS MODE - STBY | | |
| | 5 | EMS FUNC - ΔV SET | | |
| | | Slew ΔV ind to -100.0 fps | | The ΔV indicator zeroed to start accelerometer null bias check. |
| | 6 | EMS FUNC - ΔV (wait 5 sec) | | |
| T=0 | 7 | EMS MODE - NORM | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR<br>T=100<br>sec | 8 | EMS MODE - STBY | 1 | |
| | | Rcd ΔV ind | | |
| | | If ΔV drift ≤1 fps, do not bias counter | | Acceleration ≤0.01 fps2. |
| | | If ΔV drift >1 fps but <10 fps bias if desired | | Acceleration ≥0.01 fps2 but <0.1 fps2. Counter bias not required for SPS ΔV. |
| | | If ΔV drift >10 fps, EMS is no-go for all functions | | Acceleration >0.1 fps2. |
| | | CAUTION<br>Do not turn EMS FUNC - OFF prior to ΔV, or null bias will be invalid. | | |
| | 4.7.6.2 | ΔV Setup | | Specifies required steps necessary to initialize EMS for monitoring ΔVs and to generate SPS engine cutoff signal for SCS controlled SPS ΔVs. |
| | | ΔV TEST & NULL BIAS CHECK (desired), 4.7.6.1 | | |
| | | cb EMS (2) - close | 8 | |
| | 1 | EMS MODE - STBY<br>EMS FUNC - ΔV SET | 1 | |
| | 2 | Set ΔV ind - req ΔV | | |
| | 3 | EMS FUNC - ΔV | | 4.6.1.1, note 9. |

## 4.8 G&C GENERAL PROCEDURES

The procedures in this section involve both the G&N and SCS and are used most frequently during the orbital phase. Because they are fundamental to G&C operation, they are included or referenced in various forms in the more complex G&C procedures contained in sections 4.9 and 4.11 through 4.18.

Applicable G&C Reference Modes, 4.7, have been referenced throughout these procedures.

For general G&C operating data, refer to operating notes, 4.6.1.

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.8.1 G&N GENERAL | | |
| | | 4.8.1.1 (P00) CMC Idling Program | | Indicates that CMC in operate condition but not performing control or computation operations requiring coordination with other crew tasks.<br>Maintains CMC in readiness for entry into most programs. CSM and LM state vectors and W-matrices (orbital and rendezvous) are updated. (Refer to 5.6.12 of R-577, section 5.) |
| CMP | | Key V37E 00E<br>DSKY - P00 | 2,140 | |
| | | 4.8.1.2 CMC/IMU Power Down | | |
| | | (P06) CMC Power Down | | Transfers CMC from operate to standby. V69E may be used to recover from an inadvertent entrance into P06. Otherwise, when P06 selected, CMC must be powered down to standby. |
| | | Perform DAP Activation, 4.8.2.1<br>Load 0 (no DAP) in left digit of R1 | | Prevents inadvertent jet firing during power up. |
| | 1 | Key V37E 06E<br>DSKY - P06 | | |
| | 2 | FL V50 N25<br>00062 (CMC pwr down)<br>PRO (push till STBY lt - on)<br>CMC blanks DSKY dis | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | IMU Power Down | | Transfers IMU from operate to standby. |
| CDR | 1 | CMC MODE - FREE | 1 | |
| CMP | 2 | G/N IMU PWR - OFF | 100 | Guarded. Loss of IRIG wheel power will send IMU FAIL discrete to CMC. |
| | 3 | If CMC operating<br>Key V37E XXE | 2,140 | Select program not requiring IMU. |
| | | CAUTION | | |
| | | Only in case of emer shall IMU be powered down beyond stby: | | If standby power removed for >20 minutes, ISS calibration no longer valid. |
| LMP | | cb IMU HTR (2) - open | 5 | |
| | 4.8.1.3 | Startup | | Transfers ISS/CMC from standby to operate condition. Startup procedure will be first procedure selected after returning from standby, since time 2/time 1 is invalid until this is done. |
| | | CMC Startup | | |
| CMP | | PRO - (push until STBY lt out)<br>Poss CMC warning lt (20 sec max)<br>Poss RESTART lt - on<br>Poss PROG alarm<br>RSET<br>DSKY - P06<br>FL V37<br>Key 00E | 2,140 | When PRO released, CMC may revert to STBY mode. Repeat PRO until STBY light out.<br>These alarms should be ignored if they can be reset. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | **If state vctr update** | | |
| CMP | Key V96E | 2,140 | V96E suspends state vector integration. |
| | Perform CSM - (P27) CMC Update, 4.8.1.5 | | |
| | Key V37E 00E | | Re-enables P00 integration suspended by V96E. |
| | Key V37E XXE | | |
| | ISS Startup | | |
| | If CMC on | | |
| | G/N IMU PWR - on (up) | 100 | Guarded. |
| | NO ATT lt - on (90 sec) | 2,140 | |
| | NO ATT lt - out (wait 15 sec) | | |
| | Key V37E XXE | | Select IMU alignment program desired. |
| | If CMC not on | | |
| | G/N IMU PWR - on (up) | 100 | Guarded. IMU drives to 0,0,0. |
| | Wait 90 sec | | |
| CDR | IMU CAGE - on (up) ≈5 sec then off (down) | 1 | Guarded. Releases IMU. |
| | 4.8.1.4 Optics Power Control | | |
| 1 | Opt pwr up | | |
| CMP | G/N PWR - AC1 or AC2 | 5 | Provides power to reticle and condition lights in LEB. |
| | G/N OPT PWR - on (up) | 100 | |
| | OPT ZERO - OFF | 122 | OPT ZERO switch should be left at ZERO until optics use required. It is not position of this switch, but change to ZERO position that triggers zeroing routine. |
| | OPT ZERO - ZERO (≈15 sec to zero) | | |
| | COND LAMPS - ON | | |
| | RETCL BRT tw - adj | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 2 | Opt pwr down | | |
| CMP | | OPT ZERO - ZERO | 122 | |
| | | G/N OPT PWR - OFF | 100 | |
| | | G/N PWR - OFF | 5 | Removes power from reticle and condition lights in LEB. |
| | 4.8.1.5 | (P27) CSM - CMC Update | | P27 may be entered only from P00, P02. All uplinked or keyed in ΔVs and target vectors must be in same sphere of influence as CMC determined state at TIG and TIG -30. |
| | | CMC - on (req), 4.8.1.3 | | |
| | | Key V37E 00E | 2,140 | |
| | | Auto Update | | |
| | 1 | UP TLM CM - ACPT | 2 | |
| | | UP TLM - ACPT | 122 | |
| | | UPLINK ACTY lt - on | | |
| | 2 | Update complete | | |
| | | UPLINK ACTY lt - out | 2,122 | PROG window on DSKY displays 00 or 02. |
| | | UP TLM CM - BLOCK | 2 | |
| | or | UP TLM - BLOCK | 122 | |
| | 3 | Key V37E 00E | 2,140 | |
| | | Voice Transmission Update | | |
| | 1 | Liftoff time - V70E | | |
| | or | Load data block - V71E | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | or | Load singular data - V72E | 2,140 | |
| | or | Oct time increment - V73E | | |
| | | Poss OPR ERR | | If another extended verb active. |
| | 2 | DSKY - P27 | | P27 may be terminated by responding to flashing display with V34E. Data will not be incorporated for use by CMC. |
| | 3 | FL V21 N01<br>R1 Blank<br>R2 Unchanged<br>R3 AAAAA | | |
| | | Key in update data, XXXXXE (R1) CMC increments R3 by 1 | | |
| | | Repeat 3 until all data loaded | | |
| | 4 | FL V21 N02<br>R1 Blank<br>R2 Unchanged<br>R3 00330 | | |
| | | Accept update V33E | | 4.6.1.3, note 3m. |
| | | P00 or P02 - sel auto | | Data transferred from buffer storage to appropriate cells |
| | | If V96 previously keyed Key V37E 00E | | Reinstates periodic P00 integration. |
| | | Reject update Load Oct ID (XXE) of word to be corrected<br>Return to 3 | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | Time Update (Decimal) | | |
| CMP | 1 | Key V55E | 2,140 | |
| | | Poss OPR ERR | | If another extended verb active. |
| | 2 | FL V21 N24 (V25) | | All registers initially blank. |
| | | Δ time (CMC clock) 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | | Delta time change must all be provided in decimal. |
| | | Accept Load ΔT | | CMC adds ΔT to CMC clock time. |
| | | Reject V33E | | 4.6.1.3, note 3m. V33E or V34E does not update clock time. |
| | | or V34E | | |
| | 3 | Check Updated CMC Time | | |
| | | Key V06 N65E | | DSKY displays R1, R2, R3 for crew verification. |
| | | Key V37E 00E | | CMC returns to P00. |
| | | Erasable Memory Update | | |
| | 1 | Key V37E 00E | | |
| | 2 | For Seq Address<br>V21 N01E<br>Load first address XXXXE<br>Load first data word XXXXXE | | |
| | | N15E Verify CMC increments address by one (R1) | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | Load second data word XXXXXE,E<br>Load third data word XXXXXE,E | 2,140 | |
| | Continue until last address in seq filled | | |
| 3 | For Non-seq Address<br>V21 N01E<br>Load first address XXXXE<br>Load first data word XXXXXE,E<br>Load second address XXXXE<br>Load second data word XXXXXE,E | | |
| 4 | To Verify Data Loaded in Seq Address<br>V01 N01E<br>Load first address XXXXE<br>Check first data word in R1<br>N15E<br>Check second data word in R1<br>ENTR<br>Check third data word in R1<br>ENTR | | |
| 4.8.1.6 | (P47) G&N Thrusting Monitor Program | | Monitors vehicle acceleration during non-G&N controlled thrusting maneuvers, and displays ΔV applied to vehicle by thrusting maneuver. |
| | CMC - on (req), 4.8.1.3<br>ISS - on & aligned (req), 4.8.1.3 & 4.14 | | |
| 1 | Key V37E 47E | 2 | G&N monitor of ΔV highly desirable, if available, but not a requirement. P47 should be called just prior to thrusting and terminated as soon as possible |

...continued

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | | | thereafter in order to minimize errors of bias and average G. P47 also normally used during rendezvous final phase. Any ΔV under G&N control during that phase would require P34, P40, or P41. Range, range rate, and theta may be displayed by using V83 (R31). |
| | | | | Range, range rate, and phi may be displayed during P47 by using V85 (R34). Orbital parameters may be displayed by using V82 (R30). Also, an SCS orbit change can be monitored by P40 if properly combined with G&N Prethrusting and Thrusting Procedures, 4.12 and 4.13. |
| | | | | N62 (VI, H dot, H) available during P47. |
| | | Poss PROG alarm (4.8.1.16) | | R02. |
| CMP | 2 | FL V16 N83 | 2 | |
| | | ΔVX, Y, Z (cont) XXXX.X FPS | | Displayed when average G turned on. CMC requires 12.5 seconds to turn on average G if integration required is < a time step plus 1.4 seconds (earth orbit) or 2.5 seconds (lunar orbit) for each additional time step. Time step = 240 seconds (earth orbit) or 350 seconds (lunar orbit). |
| | | (To rezero registers - V32E) | | Provides capability to monitor another burn without going through R00. |
| | | Mon for furn completion | | |
| | | Rcd ΔV | | |
| | | PRO (exit P47) | | When P47 termination desired. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 3 | FL V37<br>Key XXE | 2 | If average G on, R00 turns off average G, zeros rendezvous optics mark and VHF ranging mark counters. Otherwise, counters not zeroed. It also sets or resets RNDZ, TRACK, and UPDATE flags, depending on which programs in progress or called. It may also recycle into P20. |
| | 4.8.1.7 | CMC Self-Check Procedure | | Procedure used to check CMC's ability to write into and read out of erasable memory and performs internal fixed memory banksum. |
| | | CMC - on (req), 4.8.1.3 | | |
| | 1 | Key V25 N01E<br>1365E<br>E, E, E | 2,140 | Zero self-check cells: ERCOUNT, SCOUNT, SCOUNT +1. |
| | 2 | Key V15 N01E - establish mon of self-check<br>1365E | | Begin monitor of self-check cells. |
| | 3 | Key V21 N27E<br>10E - starts self-check | | Starts complete self-check. |
| | 4 | Mon R2 & PROG lt | | |
| | | a. R2 becomes ≥3<br>Self-check has been successfully completed at least once<br>Key V21 N27E<br>0E term self-check | | Turns off self-check. |
| | | b. If PROG lt comes on<br>Coord with MSFN &/or perform malfunc SSR-1 | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.8.1.8 | Measurement and Loading of PIPA Bias | | |
| | | CMC - on (req), 4.8.1.3 | | |
| | | ISS - on (req), 4.8.1.3 & 4.14 | | ISS should be on at least one hour prior to performing this procedure to allow PIPAs to stabilize. |
| | | SCS - on (desired), 4.8.4.2 | | Provides display and SCS control capability. |
| CDR | | LOGIC 2/3 PWR - on (up) | 7 | |
| | 1 | Set Evnt Tmr 00:00 | 1 | |
| | 2 | Sel Att Cont desired, 4.7.1<br>Maintain SC Rates <0.1°/sec | | |
| CDR,CMP<br>00:00 | 3 | Key V25 N21E, E, E, E/start Evnt Tmr | 2,140 | Zeros noun 21 cells. |
| CMP | 4 | Key V06 N21 (do not ENTR) | | |
| 01:04 | 5 | Key ENTR | | |
| | 6 | Rcd PIPA counts<br>(X)R1____(Y)R2____(Z)R3____ XXXAB | | |
| | 7 | Key V21 N01E (adj PIPA bias)<br>Load 1452E (calculated X bias)<br>±ABXXXE, E<br>1454E (calculated Y bias)<br>±ABXXXE, E<br>1456E (calculated Z bias)<br>±ABXXXE | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | (If AB >99, CMC incapable of adj PIPA bias) | | |
| CMP | 8 | Key V37E 00E | 2,140 | |
| | 4.8.1.9 | (R33) CMC/LGC Clock Sync Routine | | Provides onboard method of determining difference between LGC and CMC clock time ($\Delta T$). |
| | | CMC - on (req), 4.8.1.3 | | |
| | 1 | Key V06 N65 | | |
| | 2 | Confirm sel of this routine in LM | | |
| | 3 | Perform countdown with LM crew<br>ENTR (simultaneously with LM) | | |
| | 4 | V06 N65<br>CM clock time 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC<br>Rcd this time<br>Obtain from LM the LM clock time of ENTR<br>Compute $\Delta T$<br>If more data req, return to 3<br>Comp average of $\Delta T$s | | |
| | 5 | To incorporate $\Delta T$ into CMC clock<br>Perform Time Update, 4.8.1.5 | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.8.1.10 ΔR and ΔV Threshold Change Procedure | | |
| | CMC - on (req), 4.8.1.3 | | |
| CMP | Key V24 N01E<br>Key 2002E | 2,140 | |
| | Load erasable value for desired ΔR (from following table) | | |
| | R3 2003 | | |
| | Load erasable value for desired ΔV (from following table) | | |

| Desired ΔR NM | Erasable Value | Desired ΔV FPS | Erasable Value |
|---|---|---|---|
| 0.00 | 77776 | 0.00 | 77776 |
| 0.001 | 0 | 0.0001 | 0 |
| 0.1 | 6 | 2.5 | 1 |
| 0.2 | 14 | 5.12 | 2 |
| 0.3 | 21 | 7.68 | 3 |
| 0.4 | 27 | 10.24 | 4 |
| 0.5 | 35 | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.8.1.11 A or B Erasable Value Change Procedure | | |
| | CMC - on (req), 4.8.1.3<br>P35 & P75 not operating | | Procedure ineffective if programs currently running. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | Key V24 N01E<br>Key 2021E (2023E for B)<br>Load 00000E (1:30 to 2:30)<br>Load 00003E (10:00)<br>Load 00004E (11:00 & 12:00) | 2,140 | Addresses 2021 and 2023 used by programs P35 and P75 respectively. |
| | R3 2022 (2024 for B) | | Addresses 2022 and 2024 used by programs P35 and P75 respectively. |
| | Load desired value (from following 2022/2024 table) | | |

| Desired A or B | 2022/2024 |
|---|---|
| 1:30 | 21450 |
| 1:45 | 24404 |
| 2:00 | 27340 |
| 2:15 | 32274 |
| 2:30 | 35230 |
| 10:00 | 25140 |
| 11:00 | 00720 |
| 12:00 | 14500 |

### 4.8.1.12 Flagword Monitor and Change Procedure

Flagword Monitor

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | Key V11 N01E<br>Key XXXE (flagword address) | | 4.6.13.1 for flagword addresses. |
| | R1 XXXXX (flag bit)<br>R3 00XXX (flagword address) | | |
| | Check flag bit in R1<br>KEY REL | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | Flagword Change | | |
| CMP | | Key V25 N07E | 2,140 | |
| | | Key XXXE (flagword address) | | ECADR ≤30 (octal) will select appropriate channel (except that channel 7 attempts will be ignored). |
| | | Key XXXXXE (bit ID)<br>Key 1 or 0 (1 = set flag bit, 0 = reset flag bit) | | Load code for bit to be changed as follows: |

| | A | | | B | | | C | | | D | | | E | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| code | 4 | 2 | 1 | 4 | 2 | 1 | 4 | 2 | 1 | 4 | 2 | 1 | 4 | 2 | 1 |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | Example:<br>To set REFSMMAT FLG (flagword 3, bit 13)<br>Key V25 N07E<br>77E<br>10000E<br>1E | | |
| | 4.8.1.13 | (V79) Orbrate/PTC (BBQ Mode - R64) | | Allows orbital rate or PTC maneuver by astronaut selection of rate, deadband, and X or Y axis and sets DAP parameters to maintain chosen rate. For SCS passive thermal control procedures, refer to 4.8.4.9 and 10. |
| | | CMC - on (req), 4.8.1.3<br>ISS - on & orient known (req), 4.8.1.3 & 4.14 (For orbrate, Ysm aligned to V x R) | | |
| | | SCS - on (desired), 4.8.4.2<br>RCS DAP - Load & activate (req), 4.8.2.1 | | Provides display and SCS control capability. 0.5° deadband and 0.2°/second rate recommended. |
| CDR | | LOGIC 2/3 PWR - on (up) | 7 | |
| CMP | 1 | Perform (V49E) R62, 4.8.3.4<br>Load gmbl angles for init of mnvr (orbrate or PTC) | | MGA should be ≈zero for both cases. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 2 | Disable two adjacent RCS quads | | Provides fuel conservation and lower rates (panel 8 switches, or R03, may be used to disable engines). |
| | | For PTC, att hold for 20 min | | To damp existing vehicle rates. |
| CDR | | MAN ATT P&Y (2) - ACCEL CMD<br>Enable all jets | 1 | Protects against a pitch or yaw jet firing between end of 20-minute wait period and PRO on N79. |
| CMP | 3 | Key V79E | 2,140 | |
| | | Poss OPR ERR | | If another extended verb active. |
| | | If in P00, go to 5 | | |
| | 4 | FL V06 N16 | | Permits loading of GET for maneuver initiation. Initially 00000 (present time). |
| | | Time of event 00XXX. HRS<br>000XX. MIN<br>0XX.XX SEC | | |
| | | Accept PRO | | |
| | | Reject V25E<br>Load desired data | | |
| | 5 | FL V06 N79 | | |
| | | Rate X.XXXX DEG/SEC<br>DBD XXX.XX DEG | | + for increasing CDU angles; - for decreasing CDU angles. |
| | | Axis option (X or Y) 0000X.<br>(0 = X axis, non-zero = Y axis) | | X axis (PTC), Y axis (orbrate). |
| CDR | | Accept SC CONT - CMC<br>CMC MODE - AUTO | 1 | |
| CMP | | PRO | 2,140 | Initiates pitch rate (orbrate), or roll rate (PTC), as determined by N79 load. If GET specified (non-zero) in N16, UPLINK ACTY lt will indicate maneuver initiation. KEY REL, ERR RSET or V37E XXE will extinguish light. |
| | | Reject Key V25E<br>Load desired data | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | For PTC, MAN ATT ROLL - ACCEL CMD | 1 | |
| | | MAN ATT P&Y (2) - RATE CMD | | Enables auto pitch and yaw attitude hold in N79 deadband. |
| | 6 | If desired for PTC, AUTO RCS (16) - OFF | 8 | |
| | | RHC PWR DIR (both) - OFF | 1 | Prevents inadvertent direct coil jet firings. |
| | 7 | To term mnvr | | |
| CMP | | Orbrate | 2,140 | Sets last specified R03 parameters in RCS DAP. In addition, the DAP established by this routine will be altered according to the following table: |
| | | Key V46E | | |
| | | PTC | | |
| CDR | | MAN ATT (3) - ACCEL CMD | 1 | |
| | | AUTO RCS (16) - MNA or MNB | 8 | |
| | | V46E or cycle SC CONT sw | | |
| | | MAN ATT (3) - RATE CMD | 1 | |

| SWITCHING FUNCTION | ZEROS COMMANDED RATES | RETURNS TO (R03) SPECIFIED DEADBAND | ZEROS DAP ATTITUDE ERROR |
|---|---|---|---|
| V46E | X | X | X |
| SC CONT - Cycled, CMC/SCS/CMC | X | X | X |
| CMC MODE - HOLD | X | | X |
| RHC - out of detent | X | | X |
| V37E XXE | X | X | |
| KALCMANU | * | | X |

*KALCMANU generates new commanded rates.

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.8.1.14 | G&N Passive Thermal Control Procedure | | For SCS passive thermal control procedures, refer to 4.8.4.9 and 10. |
| | | CMC - on (req), 4.8.1.3<br>ISS - on & orient known (req), 4.8.1.3 & 4.14 | | |
| | | RCS DAP - Load & activate (req), 4.8.2.1 | | 0.5° deadband and 0.2°/second rate recommended. |
| | 1 | Perform (V49E) R62, 4.8.3.4<br>(PRO on auto mnvr req, FL V50 N18) | | This option required to ensure erasable memory is properly set up. |
| CDR<br>CMP | 2 | Disable two adjacent RCS quads<br>Att hold for 20 min | 8 | Provides fuel conservation and lower rates (panel 8 switches or R03 may be used to disable engines). |
| CDR | 3 | MAN ATT P&Y (2) - ACCEL CMD<br>Enable all RCS jets | 1<br>8 | |
| CMP | 4 | Set att hold<br>Key V21 N01E | <br>2,140 | |
| | | 1013E, E (Set HOLD FLG zero) | | Sets HOLD FLG zero and inhibits maneuver until after data load. |
| | | Establish desired rate | | |

| +0.1°/sec | -0.1°/sec | +0.3°/sec | -0.3°/sec |
|---|---|---|---|
| V24 N01E | V24 N01E | V24 N01E | V24 N01E |
| 3125E | 3125E | 3125E | 3125E |
| 3E | 77774E | 12E | 77765E |
| 24400E | 53400E | 35400E | 42400E |
| V21E | V21E | V24E | V24E |
| 3176E | 3176E | 3175E | 3175E |
| 35101E | 42676E | 2E | 77775E |
| | | 27303E | 50474E |

G&N GENERAL

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 5 | Start roll mnvr<br>Key V21 N01E<br>1013E<br>70000E | 2,140 | Initiates maneuver. |
| CDR | 6 | MAN ATT ROLL - ACCEL CMD | 1 | Disables roll jets for duration of PTC. |
| CMP | 7 | Perform RCS DAP Att Dbd Change, 4.8.2.2 | | ±30° deadband is recommended. |
| CDR | 8 | AUTO RCS (16) - OFF | | |
| | 9 | To term PTC<br>MAN ATT (3) - ACCEL CMD (verify)<br>AUTO RCS (16) - MNA or MNB<br>V46E or Cycle SC CONT sw<br>MAN ATT (3) - RATE CMD | <br><br>8<br><br>1 | Re-establishes attitude hold within attitude deadband selected in R03. |

### 4.8.1.15 Saturn Rate Change

CMC - on (req), 4.8.1.3

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 1 | Key V24 N01E<br>3322E<br>XXXE<br>YYYYYE | 2,140 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|

|  | SAT RATE +1 (3322) | SAT RATE +2 (3323) |
|---|---|---|
| SIVB RATE | XXX | YYYYY |
| 0.05°/sec RPY | 161 | 77616 |
| 0.1°/sec RPY | 210 | 77567 |
| 0.2°/sec RPY | 266 | 77511 |
| *0.3°/sec RPY | 344 | 77433 |
| 0.5°/sec R,<br>0.3°/sec P&Y | 476 | 77301 |

*Use for TLI

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
|  | 4.8.1.16 | (R02) IMU Status Check |  | Check whether IMU on and, if on, whether it is aligned to an orientation known by CMC. R02 automatically called by programs requiring ISS. Provides for program alarms if ISS not on and/or IMU orientation unknown. |
|  | 1 | ISS not on (known orient not req) |  |  |
| CMP |  | PROG alarm | 2,140 | Occurs only if ISS not on. |
|  |  | FL V37 |  |  |
|  |  | Key V05 N09E (to verify alarm) |  | Alarm stored; must key V05 N09E to display alarm code. |
|  |  | 00210 (ISS not on) |  |  |
|  |  | Perform ISS turnon |  |  |
|  |  | Key XXE |  | Return to PXX at completion of ISS turnon. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 2 | ISS not on &/or orient unknown (known orient req) | | |
| CMP | | PROG alarm<br>Key V05 N09E (to verify alarm)<br>00210 (ISS not on)<br>or 00220 (IMU orient unknown) | 2,140 | Alarm stored; must key V05 N09E to display alarm code. |
| | | FL V37 | | RSET and KEY REL pressed when nature of problem determined. When CMC regains control, program cycles through R00, which resets 3-AXIS flag and may set or reset RNDZ, TRACK, and UPDATE flags, depending on which programs are in progress or called. |
| | | Key XXE | | Perform ISS turnon and/or IMU orientation determination. Reinitiate desired program. |
| | 4.8.1.17 | (V64) S-Band Antenna Routine (R05) | | Computes and displays two steerable S-band antenna gimbal angles required to point antenna toward center of earth. |
| | | CMC - on (req), 4.8.1.3 | | |
| | | ISS - on & orient known (req), 4.8.1.3 & 4.14 | | Required for valid angle displays. |
| | 1 | Key V64E | | Selects R05. Uses permanent state vector for calculations and therefore, will be based on old values if average G on. |
| | | Poss OPR ERR | | If another extended verb active. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 2 | FL V06 N51<br>Rho XXX.XX DEG<br>Gamma XXX.XX DEG | 2,140 | S-band required gimbal angles.<br>Rho - Pitch gimbal angle.<br>Gamma - Yaw gimbal angle. |
| | | Accept Rcd angles<br>PRO | | |
| | | Reject Sel Att Cont mode desired, 4.7.1<br>Mnvr SC as req | | Spacecraft maneuver will be required only if displayed angles do not provide an unobstructed view of earth. (Ref CSM Data Book, section 4.7, HGA Scan and Warning Limit, Yaw - Pitch Coord.) |
| | 4.8.1.18 | DSKY 88888 Clear Procedure | | DSKY relay failure mode will cause an all-eights display on DSKY. Affects display capability of DSKY but will not affect input/output or control functions. |
| | | Key V99 N99<br>Key V25 N01E<br>00000E<br>+99999E<br>+99999E<br>+99999 CLR, CLR, CLR<br>00000E<br>00000E<br>00000E | | |
| | | If OPR ERR<br>Start over | | |
| | | If DSKY does not clear<br>Repeat proced | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.8.2 DIGITAL AUTOPILOT (DAP) | | |
| | | 4.8.2.1 (V48) CSM - DAP Data Load Procedure (R03) | | For CMC control modes, DAP data load procedure is used to select rate, deadband, and quads. When under computer control, operating program will establish SC rates and attitude error deadbands, or crew may select other desired error deadbands via DSKY. In addition, crew has capability of selecting RCS quads for computer command of manual translation, attitude hold, or automatic and manual manuvers. |
| | | CMC - on (req), 4.8.1.3 | | |
| CMP | 1 | Key V48E | 2,140 | Extended verb 48 program calls DAP data 1, 2, and 3 in sequential order. DAP data 1, 2, or 3 may also be displayed individually by using respective verb/noun combinations, i.e., V04 N46, V06 N47, or V06 N48. |
| | | (Bit A of R1 configures TVC DAP for LM on-off) | | |
| | 2 | FL V04 N46<br>R1 - A B C D E<br>R2 - A B C D E | | |
| | | Accept PRO<br>Reject V24E load desired data | | |

|  | Vehicle Config. | Quad A/C for $\ddot{X}$ | Quad B/D for $\ddot{X}$ | Err Deadband | Rate Select |
|---|---|---|---|---|---|
| R1 | 0 = No Dap<br>1 = CSM<br>2 = CSM & LM<br>3 = CSM & SIVB<br>6 = CSM & LM (Ascent Stg only) | 0 = Fail A/C<br>1 = Use A/C | 0 = Fail B/D<br>1 = Use B/D | 0 = ± 0.5°<br>1 = ± 5.0° | 0 = 0.05°/sec<br>1 = 0.2°/sec<br>2 = 0.5°/sec<br>3 = 2.0°/sec |
|  | Roll Quad Select | Quad A | Quad B | Quad C | Quad D |
| R2 | 0 = Use B/D<br>1 = Use A/C | 0 = Fail<br>1 = Use | 0 = Fail<br>1 = Use | 0 = Fail<br>1 = Use | 0 = Fail<br>1 = Use |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
|  |  |  |  | If quads A/C and B/D (4 jets) desired for +X translation, R1-B and R1-C may be set to 0,0, or 1,1. |
|  |  |  |  | If A is failed, CMC assumes C is good. If B is failed, CMC assumes D is good. |
| CMP | 3 | FL V06 N47<br>CSM wt XXXXX. LBS<br>LM wt XXXXX. LBS | 2,140 | Value of mass used in non-DAP coding not updated unless vehicle configuration bit is 1, 2, or 6. During P40 TVC DAP reduces value for weight linearly, as function of SPS maneuver time. Maneuvers performed without using P40 could cause CMC's knowledge of weight to be compromised. |
|  |  | Accept PRO<br>Reject Key V21E, V22E or V24E<br>Load correct data |  |  |
|  | 4 | FL V06 N48<br>P Trim XXX.XX DEG<br>Y Trim XXX.XX DEG |  | If burn >0.42 second, trim values will be updated by CMC during burn. Do not load engine gimbal trim angles >9°. |
|  |  | Accept PRO - Return to prog in progress<br>Reject Key V21E, V22E or V24E<br>Load correct data |  |  |
|  | 5 | To activate DAP |  | To be done first time DAP started or after fresh start. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | CMC MODE - FREE | 1 | Prevents inadvertent jet firings. |
| CMP | Key V46E | 2,140 | Activates DAP. |
| 4.8.2.2 | RCS DAP Attitude Deadband Change Procedure | | This procedure will change RCS DAP att deadband to ±2.5, 10, 15, 20, 25, or 30°. Alternate method of establishing desired deadbands is to use V79 procedures, loading desired deadband, and specify zero rate. |
| | CMC - on (req), 4.8.1.3<br>ISS - on & orient known (req), 4.8.1.3 & 4.14<br>RCS DAP - activate (req), 4.8.2.1<br>SCS - on (desired), 4.8.4.2 | | |
| 1 | Sel CMC Att Cont - auto, 4.7.1.6 | | |
| 2 | Sel 5.0° dbd in RCS DAP, 4.8.2.1 | | |
| 3 | Key V21 N01E<br>3255E<br>Load D Band (see table) | | |

| Desired dbd | D Band |
|---|---|
| ±2.5° | 0343E |
| ±10° | 1616E |
| ±15° | 2525E |
| ±20° | 3434E |
| ±25° | 4343E |
| ±30° | 5252E |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 4 | To return to 5.0° dbd<br>THC - CW, then neut |  | Center of deadband shifted. |
|  |  | or Key V48E<br>PRO<br>PRO<br>PRO | 2,140 | Center of deadband not affected. |
|  |  | 4.8.2.3 RCS DAP Orbital Rate Procedure |  |  |
|  |  | CMC - on (req), 4.8.1.3<br>ISS - on & orient known (req), 4.8.1.3 & 4.14<br>SCS - on (desired), 4.8.4.2<br>RCS DAP - load & activate (req), 4.8.2.1<br>(Use R03 to disable 2 adjacent RCS quads)<br>Ysm aligned to V x R<br>(If R x V, complement numbers for ZZZZZ) |  | To minimize RCS propellant consumption. |
|  | 1 | Perform (V49) R62, 4.8.3.4<br>Load gmbl angles for init of orbrate |  | Gimbal angles loaded are those that are to be at initiation of orbital rate rotation. MGA should be zero. |
|  | 2 | If desired<br>Key V37E XXE (non-att cont prog) |  |  |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 3 | Establish orbrate<br>For rates 0.1°/sec or less, load oct numbers corresponding to desired mnvr rate from following table<br>For rate 0.5°/sec, go to 5 | | |
| | | Key V21 N01E<br>1013E,E (Set HOLD FLG zero) | 2,140 | Sets HOLD FLG to zero and inhibits maneuver until after data load. |
| | | Key V24 N01E<br>3127E<br>VVVVVE<br>WWWWWE | | |
| | | Key V24E<br>3131E<br>XXXXXE<br>YYYYYE | | |
| | | Key V21E<br>3200E<br>ZZZZZE | | |
| | | Key V21 N01E<br>1332E<br>70000E (Set HOLD FLG negative) | | Final ENTR initiates maneuver. |
| | | Mnvr in progress | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|

4 To term mnvr, go to 8

| ORBRATE deg/sec | CDUX | | | |
|---|---|---|---|---|
| | 0 deg | +90 deg | +180 deg | +270 deg |
| -0.100 | VVVVV = 77774 | 00000 | 00003 | 00000 |
| | WWWWW = 54300 | 61300 | 23500 | 16500 |
| | XXXXX = 00000 | 00003 | 00000 | 77774 |
| | YYYYY = 61300 | 23500 | 16500 | 54300 |
| | ZZZZZ = 42676 | 42676 | 42676 | 42676 |
| -0.095 | VVVVV = 77774 | 00000 | 00003 | 00000 |
| | WWWWW = 62200 | 62000 | 15600 | 16000 |
| | XXXXX = 00000 | 00003 | 00000 | 77774 |
| | YYYYY = 62000 | 15600 | 16000 | 62200 |
| | ZZZZZ = 44250 | 44250 | 44250 | 44250 |
| -0.090 | VVVVV = 77774 | 00000 | 00003 | 00000 |
| | WWWWW = 70000 | 62600 | 10000 | 15200 |
| | XXXXX = 00000 | 00003 | 00000 | 77774 |
| | YYYYY = 62600 | 10000 | 15200 | 70000 |
| | ZZZZZ = 45622 | 45622 | 45622 | 45622 |
| -0.085 | VVVVV = 77774 | 00000 | 00003 | 00000 |
| | WWWWW = 75600 | 63400 | 02200 | 14400 |
| | XXXXX = 00000 | 00003 | 00000 | 77774 |
| | YYYYY = 63400 | 02200 | 14400 | 75600 |
| | ZZZZZ = 47173 | 47173 | 47173 | 47173 |

...continued

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|

| ORBRATE deg/sec | CDUX 0 deg | +90 deg | +180 deg | +270 deg |
|---|---|---|---|---|
| -0.080 | VVVVV = 77775 | 00000 | 00002 | 00000 |
| | WWWWW = 43400 | 64100 | 34400 | 13700 |
| | XXXXX = 00000 | 00002 | 00000 | 77775 |
| | YYYYY = 64100 | 34400 | 13700 | 43400 |
| | ZZZZZ = 50545 | 50545 | 50545 | 50545 |
| -0.075 | VVVVV = 77775 | 00000 | 00002 | 00000 |
| | WWWWW = 51300 | 64700 | 26500 | 13100 |
| | XXXXX = 00000 | 00002 | 00000 | 77775 |
| | YYYYY = 64700 | 26500 | 13100 | 51300 |
| | ZZZZZ = 52117 | 52117 | 52117 | 52117 |
| -0.070 | VVVVV = 77775 | 00000 | 00002 | 00000 |
| | WWWWW = 57100 | 65500 | 20700 | 12300 |
| | XXXXX = 00000 | 00002 | 00000 | 77775 |
| | YYYYY = 65500 | 20700 | 12300 | 57100 |
| | ZZZZZ = 53467 | 53467 | 53467 | 53467 |
| -0.065 | VVVVV = 77775 | 00000 | 00002 | 00000 |
| | WWWWW = 64700 | 66300 | 13100 | 11500 |
| | XXXXX = 00000 | 00002 | 00000 | 77775 |
| | YYYYY = 66300 | 13100 | 11500 | 64700 |
| | ZZZZZ = 55041 | 55041 | 55041 | 55041 |

...continued

**STA/T STEP** **PROCEDURE** **PANEL** | **REMARKS**

| ORBRATE deg/sec | CDUX 0 deg | +90 deg | +180 deg | +270 deg |
|---|---|---|---|---|
| -0.060 | VVVVV = 77775 | 00000 | 00002 | 00000 |
| | WWWWW = 72500 | 67100 | 05300 | 10700 |
| | XXXXX = 00000 | 00002 | 00000 | 77775 |
| | YYYYY = 67100 | 05300 | 10700 | 72500 |
| | ZZZZZ = 56413 | 56413 | 56413 | 56413 |
| -0.055 | VVVVV = 77776 | 00000 | 00001 | 00000 |
| | WWWWW = 40300 | 67600 | 37400 | 10200 |
| | XXXXX = 00000 | 00001 | 00000 | 77776 |
| | YYYYY = 67600 | 37400 | 10200 | 40300 |
| | ZZZZZ = 57765 | 57765 | 57765 | 57765 |
| -0.050 | VVVVV = 77776 | 00000 | 00001 | 00000 |
| | WWWWW = 46200 | 70400 | 31600 | 07400 |
| | XXXXX = 00000 | 00001 | 00000 | 77776 |
| | YYYYY = 70400 | 31600 | 07400 | 46200 |
| | ZZZZZ = 61337 | 61337 | 61337 | 61337 |

CMP 5 Ysm aligned to V X R 2,140
(If R x V, complement numbers for
AAAAA and ZZZZZ)

6 Key V21 N01E
1013E,E (set HOLD FLG zero)

Sets HOLD FLG zero and inhibits maneuver until after data load.

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 7 | Establish orbrate (0.5°/sec)<br>Load oct numbers corresponding to mnvr rate from following table<br>Key V24E<br>3127E<br>VVVVVE<br>WWWWWE<br>Key V24E<br>3131E<br>XXXXXE<br>YYYYYE<br>Key V24E<br>AAAAAE<br>ZZZZZE<br>Key V21E<br>1013E<br>70000E (set HOLD FLG negative) | 2,140 | Final ENTR initiates maneuver. |

| | CDUX | | | |
|---|---|---|---|---|
| | 0° | 180° | 7.25° | 187.25° |
| VVVVV | 77755 | 00022 | 77722 | 00022 |
| WWWWW | 76077 | 01700 | 71351 | 06426 |
| XXXXX | 77775 | 00002 | --- | --- |
| YYYYY | 66367 | 11410 | --- | --- |
| AAAAA | 77773 | 77773 | 77773 | 77773 |
| ZZZZZ | 56272 | 56272 | 56272 | 56272 |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | 8 | To term mnvr<br>CMC MODE - HOLD | 1 | |
| CMP | or | Key V49E, return to 1 | 2,140 | |
| | or | Key V46E | | |
| | or | RHC - out of detent | | |
| | or | Key V37E | | |

DIGITAL AUTOPILOT (DAP)

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.8.3 EXTENDED VERBS | | |
| | | 4.8.3.1 (V35) DSKY Condition Light Test | | Procedure designed to test CMC/caution and warning, DSKY interface. |
| | | CMC - on (req), 4.8.1.3 | | |
| CMP | 1 | Key V37E 00E (req) | 2,140 | Must be performed while in P00. |
| | 2 | Key V35E | | |
| | 3 | Mon the following events | | |
| | | a. All DSKY condition lts - on | | |
| | | b. ISS warning lt - on<br>CMC warning lt - on | | |
| | | c. All DSKY numerical windows disp 8<br>Sign positions in R1, R2, R3 show +<br>V, N windows flash | | |
| | | Wait 5 sec | | |
| | | d. All DSKY warning lts - out | | NO ATT will be left on if coarse align occurring. |
| | | e. ISS lt - out<br>CMC lt - out | | |
| | | f. Old PROG number will be disp<br>Interrupted disp (if any) will be restarted | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.8.3.2 | (V42) Torque Gyros | | Fine aligns stable member by torquing gyros (primarily for ground use). |
| | | CMC - on (req), 4.8.1.3<br>ISS - on (req), 4.8.1.3 & 4.14 | | |
| CMP | 1 | Key V37E 00E | 2,140 | |
| | 2 | For Load <100°<br>Key V42E | | |
| | | Poss OPR ERR | | If another extended verb active, or IMU stall routine in use. |
| | or | For Load >99.999°<br>Key V21 N02E<br>2757E<br>XXXXXE<br>N15E<br>XXXXXEE<br>YYYYYEE<br>YYYYYEE<br>ZZZZZEE<br>ZZZZZE<br>Key V42E | | Load >90 deg should not be performed during flight. |
| | | Poss OPR ERR | | If another extended verb active, or IMU stall routine in use. |
| | 3 | FL V21 N93 (request load) | | If SC CONT at CMC and CMC MODE at AUTO or HOLD, DAP will maneuver vehicle to follow the platform as it moves. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | Δ Gyro X, Y, Z XX.XXX DEG | 2,140 | Registers initially blank. |
| | | Accept Load desired data<br>DSKY displays V42<br>NO ATT lt - out | | |
| | | Reject V33E<br>DSKY displays V42<br>NO ATT lt - out | | Key V33E if gyro torquing registers loaded prior to keying V42E. Also refer to 4.6.1.3, note 3m. |
| | 4.8.3.3 | (V43) Load FDAI Error Needles | | Loads crew specified angles into FDAI error needles (primarily for ground use). |
| | | CMC - on (req), 4.8.1.3<br>ISS - on (req), 4.8.1.3 | | |
| | 1 | Key V37E 00E | | V43E can be executed only from P00. |
| | 2 | Key V43E | | |
| | | Poss OPR ERR | | V43E cannot be executed if CMC not in P00, IMU in coarse align or zero ICDU mode, or if another extended verb active. (Latter is constraint after liftoff.) |
| | 3 | FL V21 N22 (request load)<br>R, P, Y XXX.XX DEG | | Registers initially blank. |
| | | Load desired err angles | | Maximum effective angle which may be loaded is ±16.88 degrees. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.8.3.4 (V49) CSM Crew Defined Maneuver (R62) | | Provides method of performing CMC controlled maneuver to crew defined attitude. |
| | | CMC - on (req), 4.8.1.3<br>ISS - on & orient known (req), 4.8.1.3 & 4.14<br>SCS - on (req), 4.8.4.2 | | |
| CMP | 1 | Key V37E 00E | 2,140 | Routine R62 may be called from P00 only. |
| | 2 | Sel Tot Att (ISS) Disp, 4.7.2.5 | | Both FDAIs recommended so either reference system (IMU or GDC) may be monitored. (CMC attitude error and rate displays available.) |
| | 3 | Key V49E | | |
| | | Poss OPR ERR | | If another extended verb active. |
| | 4 | FL V06 N22 (fnl gmbl angles)<br>R, P, Y XXX.XX DEG | | |
| | | Accept PRO<br>Reject V25E load desired gmbl angles | | |
| | | (R60 - Attitude Maneuver Routine) | | Provides for maneuver (automatically or manually) to specified attitude. |
| | 5 | FL V50 N18 (auto mnvr request)<br>R, P, Y XXX.XX DEG | | Required gimbal angles. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | Accept | BMAG MODE (3) - RATE 2 | 1 | |
| | | Sel CMC Att Cont Auto, 4.7.1.6 | | |
| CMP | | PRO | 2,140 | May be performed second time as attitude trim. |
| | | V06 N18<br>R, P, Y XXX.XX DEG<br>Mon auto mnvr on FDAI | | Static display until completion of auto manuever and reverts to FL V50 N18. |
| | Reject | Key V62E | | Selects Mode 2, total attitude error on FDAI needles. |
| | | RHC - Null FDAI needles | | Any input from RHC (RHC out of detent) will be interpreted by CMC as a manual override and will cause immediate termination of auto maneuver calculation. |
| | When att satisfactory<br>ENTR | | | |
| 4.8.3.5 | | (V67) Start W-Matrix RSS Error Display | | Provides display of RSS position and velocity errors, and opportunity to load new initialization values. However, initialization will not take place until next opportunity. |
| | | CMC - on (req), 4.8.1.3 | | |
| | 1 | Key V67E | | |
| | | Poss OPR ERR<br>Exit | | If another extended verb in process. |
| | 2 | FL V06 N99 | | |
| | | POS ERR XXXXX. FT | | RSS value of position error. |
| | | VEL ERR XXXX.X FPS | | RSS value of velocity error. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | Option code 0000X | 2,140 | Option code: (initially 00000)<br>00001 - Rendezvous<br>00002 - Orbital<br>00003 - Cislunar |
| | | | R3 must be loaded for desired option. Otherwise, reinitialization will not occur. |
| | Accept PRO | | Bypasses reinitialization, if R3 = 00000. |
| | Reject Key V25E | | |
| | Load desired data (per following tables) | | To initialize at new values. Initialization occurs next time a measurement is made. |
| | W-MATRIX TABLE (V67) | | N99 values to be loaded to obtain desired POS ERR and VEL ERR elements with corresponding octal values for erasable. |

W-MATRIX TABLE (V67)

| | | | |
|---|---|---|---|
| WRENDPOS | 2000-P20 | WRENDVEL | 2001-P20 |
| WORBPOS | 2004-P22 | WORBVEL | 2005-P22 |
| WMID POS | 3000-P23 | WMIDVEL | 3001-P23 |

| N99 R1 | 1000 ft | OCT | N99 R2 | fps | OCT |
|---|---|---|---|---|---|
| 10000 | 10 | 137 | 10 | 10 | 762 |
| 08000 | 8 | 114 | 8 | 8 | 620 |
| 06000 | 6 | 71 | 6 | 6 | 453 |
| 04000 | 4 | 46 | 4 | 4 | 307 |
| 02000 | 2 | 23 | 2 | 2 | 144 |
| 01000 | 1 | 11 | 1 | 1 | 61 |
| 00800 | .8 | 7 | .8 | .8 | 50 |
| 00600 | .6 | 5 | .6 | .6 | 34 |
| 00400 | .4 | 3 | .4 | .4 | 24 |
| 00300 | .2 | 2 | .2 | .2 | 10 |
| 00100 | .1 | 1 | .1 | .1 | 5 |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.8.3.6 | (V74) Initialize Erasable Dump Via Downlink | | Dumps all eight banks of erasable memory via downlink. |
| | | CMC - on (req), 4.8.1.3 | | |
| CMP | 1 | Key V74E<br>(V74 will deliver two complete dumps) | 2,140 | |
| | 4.8.3.7 | (V91) Display Banksum | | Displays sum of each bank for comparison. |
| | | CMC - on (req), 4.8.1.3 | | |
| | 1 | Key V37E 00E | | Procedure must be performed in P00. |
| | 2 | Key V91E | | |
| | | Poss OPR ERR | | If another extended verb active. |
| | 3 | FL V05 N01 | | |
| | | Banksum XXXXX | | Sum of bits of chosen bank. |
| | | Bank No. XXXXX | | Number of bank being read. |
| | | Bugger word XXXXX | | Factor required to make $\lvert R1\rvert = \lvert R2\rvert$. |
| | | Accept V34E (halt summing) | | Expected bank and banksum acceptable ( $\lvert R1\rvert = \lvert R2\rvert$ ). |
| | | Reject PRO, recycle 3 (next bank) | | 43 banks. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.8.4 SCS GENERAL | | |
| | | 4.8.4.1 SCS Power Down | | Describes safe power-down configuration. |
| | 1 | Provide Safe Sys Configuration | | |
| CDR | | EMS FUNC - OFF | 1 | |
| | | EMS MODE - STBY | | |
| | | AUTO RCS (16) - OFF | 8 | |
| | | BMAG MODE (3) - RATE 2 | 1 | |
| | | SPS THRUST - NORM | | Normal position selected to prevent inadvertent SPS firing. |
| | 2 | Remove SCS Pwr | | |
| | | TVC SERVO PWR (both) - OFF | 7 | |
| | | FDAI/GPI PWR - OFF | | |
| | | LOGIC 2/3 PWR - OFF | | |
| | | ELEC PWR - OFF | | |
| | | SIG CONDR/DR BIAS PWR (both) - OFF | | |
| | | BMAG PWR (both) - WARMUP | | |
| | | RHC PWR NORM (both) - OFF | 1 | |
| | | xxxxxxxxxxxxxxxxxxxxxx<br>For tot pwr down<br>W BMAG 1 PWR - OFF<br>xxxxxxxxxxxxxxxxxxxxxx | 7 | When BMAG switches set to OFF, 40-minute warmup may be required (BMAG 1 and 2 TEMP lights extinguish when operating temperature is reached) before normal operation of BMAGs. If set from ON to WARMUP, BMAG TEMP lights should remain out. |
| | 3 | Pwr Down ORDEAL | | |
| | | FDAI sw (both) - INRTL | 13 | |
| | | EARTH/LUNAR - PWR OFF | | |
| | | LTG - OFF | | |

SCS GENERAL

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4 | Pwr Down COAS | | |
| LMP | | COAS PWR (2) - OFF | 15,16 | |
| CDR,<br>CMP | 5 | Miscellaneous | | |
| | | THC - neut, LOCKED | | |
| | | RHC (both) - LOCKED | | |
| | 6 | Remove Logic Sw Pwr | | Optional step to place panel 1 switches on logic buses in their OFF position. Relationship between switch positions and logic buses described in 4.6.3. |
| CDR | | FDAI SCALE - 5/1 | 1 | |
| | | FDAI SEL - 1 or 2 | | |
| | | ATT SET - GDC | | ATT SET switch should be left at GDC when not in use. Also refer to 4.6.1.1, note 5. |
| | | MAN ATT (3) - RATE CMD | | |
| | | LIM CYCLE - on (up) | | |
| | | ATT DBD - MAX | | |
| | | RATE - LO | | |
| | | EMS ROLL - OFF | | |
| | | TVC GMBL DR (2) - 1 | | |
| | 4.8.4.2 | SCS Power Up | | Used to power up display and control electronics of SCS. |
| | 1 | Provide Safe Sys Configuration | | |
| | | AUTO RCS (16) - OFF | 8 | |
| | | BMAG MODE (3) - RATE 2 | 1 | Cages BMAGs and prevents attitude error signal, if any, from causing jet firings when RCS enabled. |
| | 2 | Set Pwr Switches | | |
| | | LOGIC 2/3 PWR - on (up) | 7 | Configures G&C for future command/control functions. |
| | | ELEC PWR - GDC/ECA | | Provides power for control and GDC electronics. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | 7 | Switch 1 also provides SCS signal conditioner power for the following TLM functions: rate and attitude error, SCS auto TVC, MTVC, gimbal position transducer and RHC proportional rate commands. Switch 2 provides SCS signal conditioner power for TVC pitch and yaw differential clutch current TLM. For increased reliability, switches should not be set on same bus. Also refer to 4.6.1.2, note 5. |
| CMP | | BMAG TEMP lt (2) - out | 2 | |
| CDR | | FDAI/GPI PWR - OFF | 7 | If FDAIs are powered when BMAGs come up to speed, rate needles will oscillate full scale. |
| | | BMAG PWR (both) - ON | | Provides rate and attitude source for control and display functions. |
| | | FDAI/GPI PWR - BOTH | | Provides power for display electronics. |
| | | RHC PWR NORM (both) - AC/DC | 1 | Provides power to RHC for manual control functions if needed. |
| | 4.8.4.3 | Drift Rate Adjust | | Permits periodic adjustment of finite drift rates of <1 deg/sec. It is intended for use during long periods of drift such as in thermal control where high power consumption undesirable. |
| | 1 | Set up Pwr Sw | | |
| | | LOGIC 2/3 PWR - on (up) | 7 | Powers panel 1 controls for command/control functions. |
| | | ELEC PWR - ECA | | Powers control electronics. |
| CMP | | BMAG TEMP lt (2) - out | 2 | |
| CDR | | FDAI/GPI PWR - OFF | 7 | If FDAIs are powered when BMAGs come up to speed, rate needles will oscillate full scale. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | BMAG 2 PWR - ON | 7 | Provides rate source for control and display functions. |
| | | FDAI/GPI PWR - 1 | | Provides power for display electronics. |
| | | SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | | 4.6.1.2, note 5. |
| | | RHC PWR NORM (both) - AC/DC | 1 | |
| | 2 | Establish Rate Disp for Ball 1, 4.7.2.1 | | |
| | | FDAI SEL - 1 | | |
| | | BMAG MODE - RATE 2 | | |
| | 3 | Establish SCS Min Imp, 4.7.1.2 | | |
| | | MAN ATT (3) - MIN IMP | | |
| | | SC CONT - SCS | | |
| | | AUTO RCS - MNA or MNB | 8 | Single jet control in each axis preferred to allow fuel conservation. |
| | 4 | Adj Veh Rates | | FDAI SCALE - 5/1 recommended since expected rates will be <1 deg/sec. |
| | | RHC - ARMED | | |
| | | Adj rates using FDAI 1 | | |
| | | RHC - LOCKED | | |
| | 4.8.4.4 | Minimum Power SCS Attitude Hold (Three or Two Axes) | | Provides attitude hold in two or three axes, as desired, for prolonged periods using low power consumption. |
| | 1 | Set Pwr Sw | | |
| | | LOGIC 2/3 PWR - on (up) | 7 | |
| | | ELEC PWR - ECA | | If total attitude display desired, select GDC/ECA. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | BMAG TEMP lt (2) - out | 2 | |
| CDR | | FDAI/GPI PWR - OFF | 7 | If FDAIs powered when BMAGs come up to speed, rate needles will oscillate full scale. |
| | | SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | | 4.6.1.2, note 5. |
| | | BMAG PWR (both) - ON | | |
| | | FDAI/GPI PWR - 1 | | Provides power for display electronics. |
| | 2 | Establish SCS Att Hold/Rate Cmd, 4.7.1.4 | | |
| | | MAN ATT (3 or 2) - RATE CMD | 1 | Selection by axis using these switches will determine axes in which attitude hold is enabled. |
| | | LIM CYCLE - on (up) | | |
| | | ATT DBD - MAX | | |
| | | RATE - LO | | |
| | | SC CONT - SCS | | |
| | | BMAG MODE (3) - RATE 2 | | |
| | | AUTO RCS - MNA or MNB | 8 | Single jet control in each axis preferred to allow fuel conservation. |
| | | BMAG MODE (3 or 2) - ATT 1/RATE 2 | 1 | |
| | 3 | Sel Disp, 4.7.2.1 & 2 | | |
| | | FDAI SEL - 1 | | |
| | | FDAI SOURCE - GDC | | |
| | 4 | Mon FDAI 1 att err during limit cycling | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.8.4.5 | SCS Attitude Maneuver | | Provides options for performing SCS attitude maneuver during normal orbital operations or to satisfy specific mission requirements. Permits easy correlation to G&C Reference Modes, 4.7, and other G&C General Procedures, 4.8. |
| | 1 | The following are req<br>ISS - on & orient known (for step 3a), 4.8.1.3 & 4.14<br>SCS - on, 4.8.4.2 | | |
| CDR | 2 | Obtain mnvr data from MSFN | | |
| | | a. Fnl mnvr angles<br>R___°, P___°, Y___° | | |
| | or | b. External ref cues | | |
| | 3 | Maneuver | | Select FDAI display as required. Also refer to 4.6.1.2, note 6. |
| | | a. To specified mnvr angles<br>If ISS avail<br>Perform GDC align to IMU gmbl angles, 4.8.4.6<br>If ISS not avail<br>Perform alternate SC Inertial Att Determination, 4.14.2.1 | | |
| | | Set ATT SET tw - to desired values (step 2) | 1 | |
| | | Sel att cont mode, 4.7.1 | | Mode should be compatible with magnitude of maneuver - e.g., rate command, acceleration command or minimum impulse, and desired rates. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | RHC - mnvr | | Use total attitude and/or attitude error displays as required to obtain final gimbal angles. |
| | or b. To external ref<br>Sel att cont mode, 4.7.1 | | |
| | RHC - mnvr | | Null rates at desired orientation. |
| | 4.8.4.6 GDC Alignment to IMU Gimbal Angles | | Provides two methods for aligning GDC to IMU. |
| | 1 The following are req<br>CMC - (on for step 3b), 4.8.1.3<br>ISS - on & orient known, 4.8.1.3 & 4.14<br>SCS - on, 4.8.4.2 | | |
| | FDAI 1 sw - INRTL (desired) | 13 | Provides easy comparison between FDAI and ATT SET values. |
| | 2 Establish Att Cont, 4.7.1<br>Damp veh rates | | Selected to prevent drift error during alignment process. |
| | 3 Perform Att Err Disp - ISS Att Set Source, 4.7.2.4 | | 4.6.1.1, note 5. |
| | a. FDAI SOURCE - ATT SET<br>ATT SET - IMU<br>FDAI SEL - 1 | 1 | |
| | ATT SET tw - null FDAI 1 errors | | Verify that ATT SET tw and FDAI 1 indicate same total attitude because false nulling of error needles could occur 180° from desired attitude. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP<br>CDR | or b. | V16 N20E<br>ATT SET tw - adj to IMU gmbl angles on DSKY | 2,140<br>1 | |
| | or c. | ATT SET tw - adj to IMU gmbl angles as ind on FDAI | | |
| | 4 | Align GDC, 4.7.3<br>ATT SET - GDC<br>GDC ALIGN pb - push, hold<br>FDAI SEL - 1/2 | | Verify both FDAIs indicate same total attitude. |
| | 4.8.4.7 | Attitude Reference System Comparison | | |
| | 1 | The following are req<br>CMC - on, 4.8.1.3<br>ISS - on & orient known, 4.8.1.3 & 4.14<br>SCS - on, 4.8.4.2 | | |
| CMP | 2 | Key V37E 00E | 2,140 | |
| | 3 | Establish Att Cont, 4.7.1<br>Damp veh rates | | |
| | 4 | Key V06 N20E (ICDU angles)<br>R, P, Y XXX.XX DEG | | Required to allow rough ATT SET adjustment to IMU gimbal angles prior to nulling operation. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 5 | Perform ATT SET/IMU comparison, 4.7.2.4 | | |
| CDR | | FDAI SEL - 1 | 1 | |
| | | FDAI SOURCE - ATT SET | | |
| | | ATT SET - IMU | | 4.6.1.1, note 5. |
| | | ATT SET tw (3) - set ≈ to DSKY values, null FDAI 1 att err | | |
| CMP | | ENTR (when nulled) | 2,140 | Error needle bias, if any, determined and may be subtracted from GDC drift in step 6 (postflight). |
| | | Rcd DSKY values<br>R___°, P___°, Y___° | | |
| | | Rcd ATT SET values<br>R___°, P___°, Y___° | 1 | |
| | 6 | Perform ATT SET/GDC comparison | | |
| CDR | | ATT SET - GDC | | |
| | | ATT SET tw (3) - null FDAI 1 att err | | |
| CMP | | ENTR (when nulled) | 2,140 | |
| | | Rcd DSKY values<br>R___°, P___°, Y___° | | |
| | | Rcd ATT SET values<br>R___°, P___°, Y___° | 1 | |
| | 4.8.4.8 | ORDEAL Initialization | | Aligns one or both FDAIs to local vertical coordinates. |
| | 1 | The following are req | | |
| | | CMC - on (for steps 4a & 7a), 4.8.1.3 | | |
| | | ISS - on & aligned, nom option (for step 7a), 4.8.1.3 & 4.14 | | IMU and/or SCS attitude reference system must be aligned with +Y axis of reference along (V x R), where V is velocity vector and R is position vector from center of earth/moon. |
| | | SCS - on, 4.8.4.2 | | |
| | 2 | Sel Tot Att Disp, 4.7.2.5 | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | 3 | Set ORDEAL cont, 4.7.2.6<br>FDAI 2 or 1 sw - ORB RATE<br>EARTH/LUNAR - as req<br>MODE - HOLD/FAST | 13 | Either or both FDAIs may be driven by ORDEAL. |
|  | 4 | Obtain alt setting |  |  |
| CMP | a. | (R30) orb param disp routine<br>Key V82E<br>Record Ha and Hp<br>Calculate ave | 2,140 |  |
|  | or b. | (P21) ground track determination prog<br>Key V37E 21E<br>Record alt for 10-min intervals of present orb<br>Calculate ave |  |  |
|  | or c. | MSFN<br>If CMC in STBY, obtain alt setting from MSFN |  |  |
| CDR | 5 | ALT SET - adj to proper alt | 13 |  |
|  | 6 | Sel att cont mode, 4.7.1, & mnvr to place +Xsc in orb plane (0° yaw) |  |  |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | 7 | Obtain $\theta$ - pitch angle to lcl horiz | | $\theta$ is the angle included between +Xsc and local horizontal. Angle in range 0° to 180° indicates +Xsc above local horizontal plane. Total range 0° to 360°. |
| | | a. (R31) rndz param disp routine | | |
| CMP | | Key V83E | 2,140 | |
| CDR | or | b. MSFN<br>If CMC in STBY, obtain $\theta$ from MSFN based on +Xsc pointed at horiz | | |
| | | Mnvr to point +Xsc at horiz, 4.8.4.5 | 13 | $\theta$ based on +Xsc pointed at horizon dependent on present altitude. |
| | 8 | Slew FDAI to $\theta$ | | The CMC display of $\theta$ is from 0° to 360°. |
| | 9 | MODE - OPR/SLOW | | |
| | | Slew/adj FDAI precisely | | FDAI may be more accurately adjusted using 1° marks if yaw angle is 0° and roll angle 0° or 180°. When momentary SLEW switch released, ORDEAL is in operate mode. |
| | 10 | Repeat 7 thru 9 as req | | FDAI sw (both) must be at INRTL (pwr OFF or not) to display pitch inertial attitude. |
| | 4.8.4.9 | SCS Passive Thermal Control Using Wobble Mode | | For G&N Passive Thermal Control Procedure, refer to 4.8.1.13 and 14. |
| | 1 | Set up pwr sw | | |
| | | LOGIC 2/3 PWR - on (up) | 7 | |
| | | ELEC PWR - ECA | | If total attitude display desired, select GDC/ECA. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | BMAG TEMP lt (2) - out | 2 | |
| CDR | | FDAI/GPI PWR - OFF | 7 | If FDAIs powered when BMAGs come up to speed, rate needles will oscillate full scale. |
| | | BMAG PWR (both) - ON | | |
| | | FDAI/GPI PWR - 1 | | |
| | | SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | | 4.6.1.2, note 5. |
| | | RHC PWR NORM (both) - AC/DC | 1 | |
| | 2 | Establish SCS att hold/rate cmd | | |
| | | MAN ATT (3) - RATE CMD | | |
| | | LIM CYCLE - on (up) | | |
| | | ATT DBD - MIN | | This switching assumes RCS not enabled or attitude error needles are nulled before this switching performed. |
| | | RATE - LO | | |
| | | SC CONT - SCS | | |
| | | BMAG MODE (3) - RATE 2 | | |
| | | AUTO RCS A/C ROLL or B/D ROLL (4) - MNA or MNB | 8 | Only one pair of roll quads should be enabled. |
| | | AUTO RCS PITCH & YAW - set for single jet oper | | Single jet control in PITCH and YAW provides reduced RCS authority for attainment of minimum rates. |
| | | BMAG MODE (3) - ATT 1/RATE 2 | 1 | |
| | 3 | Select Disp | | |
| | | FDAI SEL - 1 | | |
| | | FDAI SOURCE - GDC | | |
| | 4 | Mnvr SC to desired att | | Maneuver should place desired wobble axis in CSM -Z+Y quadrant, _____° from X axis. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | 5 | Achieve pitch up & yaw right rates of 0.01-0.02°/sec | | Allow CSM to deadband to these rates. Rate may be obtained manually if minimum impulse control used. |
| | 6 | MAN ATT ROLL - ACCEL CMD | 1 | |
| | | LIM CYCLE - OFF | | |
| | | ATT DBD - MAX | | |
| | | RATE - HI | | |
| | | BMAG MODE (3) - RATE 2 | | |
| | | AUTO RCS ROLL (8) - MNA or MNB | 8 | |
| | | Init _____°/sec roll rate | | Full roll authority can be used to establish this rate with one RHC action. |
| | | AUTO RCS (16) - OFF | | |
| | 4.8.4.10 | SCS Passive Thermal Control Using BAR-B-Q Minimum Power Mode | | For G&N Passive Thermal Control Procedure, refer to 4.8.1.13 and 14. |
| | 1 | Set up pwr sw | | |
| | | LOGIC 2/3 PWR - on (up) | 7 | |
| | | SCS ELEC PWR - ECA | | If total attitude display desired, select GDC/ECA. |
| CMP | | BMAG TEMP lt (2) - out | 2 | |
| CDR | | FDAI/GPI PWR - OFF | 7 | If FDAIs powered when BMAGs come up to speed, rate needles will oscillate full scale. |
| | | BMAG PWR (both) - ON | | |
| | | FDAI/GPI PWR - 1 | | |
| | | SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 | | 4.6.1.2, note 5. |
| | | RHC PWR NORM (both) - AC/DC | 1 | |
| | 2 | Sel Disp | | |
| | | FDAI SEL - 1 | | |
| | | FDAI SOURCE - GDC | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | 3 | Mnvr SC to desired att | | |
| | 4 | Establish 2 axis SCS att hold/rate cmd | | |
| | | MAN ATT P&Y (2) - RATE CMD | 1 | |
| | | MAN ATT ROLL - ACCEL CMD | | |
| | | LIM CYCLE - on (up) or MIN IMP | | |
| | | ATT DBD - MAX | | |
| | | RATE - HI | | |
| | | SC CONT - SCS | | |
| | | AUTO RCS PITCH & YAW - set for single jet oper | 8 | Engine combinations available for single jet control are: |
| | | AUTO RCS A/C ROLL or B/D ROLL (4) - MNA or MNB | | |
| | | BMAG MODE (3) - ATT 1/RATE 2 | 1 | |
| | 5 | Init 0.1°/sec roll rate | | |
| | 6 | Mon FDAI 1 att err during limit cycling | | |

SINGLE JET CONTROL

| | | | | |
|---|---|---|---|---|
| PITCH | A3-A4 | C3-C4 | A3-C4 | C3-A4 |
| YAW | B3-B4 | D3-D4 | B3-D4 | D3-B4 |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | 4.9 RENDEZVOUS | | Provides procedural requirements for CSM rendezvous with LM. |
| | 4.9.1 CSM/LM RENDEZVOUS | | |
| | CMC - on (req), 4.8.1.3 | | |
| | ISS - on & orient known (req), 4.8.1.3 & 4.14 | | |
| | SCS - on (req), 4.8.4.2 | | |
| | Opt pwr up (req), 4.8.1.4 | | Required for LM acquisition and SXT tracking during rendezvous phase. |
| | RCS DAP - load & activate (req), 4.8.2.1 | | |
| | Set up for VHF rng, 4.5.6.6 | | |
| 1 | Verify/confirm with MSFN, oper status of LM &/or CSM sys | | |
| 2 | Select desired att cont, 4.7.1 | | |
| 3 | Select desired disp, 4.7.2 | | |
| 4 | Perform rndz nav, 4.11 | | |
| 5 | If CSM passive<br>Perform targeting, 4.12.2 | | |
| 6 | If CSM active<br>Perform rndz prethrusting, 4.12.2<br>Perform thrusting, 4.13 | | |

## 4.10 LM INTERFACE & EVA ACTIVITIES

### 4.10.1 MANEUVERS

### 4.10.1.1 CSM/SLA Separation, Transposition and Docking

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 1 | The following are req<br>CMC - on, 4.8.1.3 | | Provides G&N control capability. |
| | | COAS - installed & calib, 4.14.1.8 | | |
| | | LM Docking Sys Probe Extension & Stat Check, 4.4.1.1 (step 5) | | |
| | | SCS - on, 4.8.4.2 | | Provides SCS control capability. |
| | | ISS - on & orient known, 4.8.1.3 & 4.14 | | |
| | | RCS DAP load & activate, 4.8.2.1<br>R1 - 111XX } Noun 46 Disp<br>R2 - X1111 } | | Establishes G&N control capability as follows: CSM configuration, 4 quad translation (quads A, B, C, D - on). |
| | | SIVB mnvrs to sep att | | CSM maneuver should be performed in the following attitude and rate deadbands in either the CMC or SCS control modes to simplify the control task during separation. |
| CMP | | Key V16 N20E<br>(N20) R ____ P ____ Y ____<br>-60° +180° + to -<br>(N22) R ____° P ____° Y ____°<br>Load N22 (Docking att) | 2 | |

| | CMC | SCS |
|---|---|---|
| ATT DBD | ±0.5° (R03) | ±0.2° (MIN) |
| RATE DBD | +0.2°/sec (fixed) | ±0.2°/sec (LO) |
| RATE CMD (RHC) | +0.5°/sec (R03) | ±0.65°/sec |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | Pnl configuration per 4.3.2.1 | | Postorbital insertion status checklist. |
| | 2 | Pnl reconfiguration & sep prep | | |
| CMP | | Key V60E | 2 | Nulls FDAI 1 error needles, N17 = N20. |
| | | Key V63E | | Permits display of error between present and astronaut loaded gimbal angles on FDAI 1, N20 and N17. |
| | | Verify SM RCS activation | | |
| | | SM RCS PRPLNT tb (8) - gray | | |
| | | Set pnl 1 SCS att cont | | |
| CDR | | THC PWR - on (up) | 1 | |
| | | RHC PWR DIR (both) - MNA/MNB | | Enables direct RCS coils for contingency takeover. |
| | | RHC PWR NORM (both) - AC/DC | | |
| | | SC CONT - SCS | | |
| | | CMC MODE - FREE | | |
| | | BMAG MODE (3) - RATE 2 | | Cages the BMAGs and prevents attitude maneuver signals from causing them to hit their stops. |
| | | ATT DBD - MIN | | |
| | | RATE - LO | | |
| | | LIM CYCLE - OFF | | |
| | | LV IND/GPI sw - SII/SIVB (verify) | | |
| | | AUTO RCS (16) - MNA or MNB | 8 | Jets enabled on MN bus A & B should be selected so that command will be maintained for the most critical maneuvers in case of either dc bus failure. |
| | | MAN ATT (3) - MIN IMP | 1 | Establishes proportional manual control with rate damping for SCS backup. |
| | | TVC SERVO PWR 1 - AC1/MNA | 7 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | Establish sep performance cues | | |
| | | Perform EMS ΔV Test & Null Bias check, 4.7.6.1, & EMS ΔV Setup, 4.7.6.2, except set ΔV ind at -100 to avoid oper around the 0.0 fps settings | 7 | |
| | | GDC - align, 4.8.4.6 | | |
| | | Establish displays | | |
| | | FDAI SEL - 1/2 | 1 | Enables G&N on FDAI 1, SCS on FDAI 2. |
| CDR,CMP | | Key V37E 00E | 2 | Integrates state vector forward. |
| CDR | | EVNT TMR RSET - RSET | 1 | RSET position is momentary. |
| | | EVNT TMR ind - 00:00 | | |
| | 3 | Enbl sequencer logic | | Provides power to sequencer and pyro circuits for separation. |
| | | cb SECS ARM (2) - close | 8 | |
| | | After MSFN AOS | | |
| | | SECS LOGIC (both) - on (up) | | Lever lock. |
| | | Report logic arm | | |
| | | After GO from MSFN | | |
| | | SECS PYRO ARM (2) - on (up) | | Lever lock. |
| | | Perform fnl presep func | | |
| CMP | | V66E | 2 | Transfer CSM state vector to LM storage. |
| | | Key V37E 47E (thrust mon) | | Permits display of velocity change during thrusting on DSKY. Perform ≈60 seconds prior to separation to minimize effective PIPA bias. |
| | | FL V16 N83 | | |
| | | ΔVX, Y, Z (cont) XXXX.X FPS | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | RHC 2 - ARMED | | |
| CMP | | RCS CMD - ON | 2 | ON position is momentary. Enables RCS latching relay in SECS. This function also accomplished automatically by SECS. |
| CDR | | RHC - RCS check (audible) | | |
| | | SC CONT - CMC | 1 | |
| | | MAN ATT (3) - RATE CMD | | |
| | 4 | Separation | | |
| LMP | | FC REAC VLVS - LATCH | 3 | |
| CDR | | EMS MODE - NORM | 1 | Perform 30 seconds prior to separation to minimize effective EMS drift. |
| | | CMC MODE - HOLD or AUTO | | |
| | | THC - ARMED | | |
| -00:03 | | THC - +X & hold 3 sec prior to sep | | Initiates preseparation tension. |
| 00:00 | | CSM/LV SEP pb - push & hold | | Guarded. |
| | | Start Evnt Tmr | | |
| | | LV TK PRESS ind (4) - 0 | | Indicates physical separation. |
| | | LV ENG 1 lt - out | | |
| | | CSM/LV SEP pb - rel | | |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>x x | | |
| | | No sep | | |
| | | THC - CCW (leave in detent) | | Activates automatic SECS separation and direct RCS ullage. |
| 00:00 | | Evnt Tmr rset & counting up (auto) | | |
| | | RCS dir ullage (auto) | | SECS delays separation for 3 seconds. |
| 00:03 | | LV TK PRESS ind (4) - 0 | | Indicates physical separation. |
| | | LV ENG 1 lt - out | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | | | |
| 00:07 max | | THC - neut<br>RCS dir ullage terminated (auto)<br>Confirm $\Delta V \approx 1$ fps | | Terminates automatic direct RCS ullage. |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| 00:04 max | | THC - neut | | After ≈4 seconds of free thrusting. |
| | | $\Delta V \approx -100.8$ fps | | Based on CSM weight of 65,150 pounds an average separation $\Delta V$ as follows:<br>In 4.4 seconds $\Delta V = -100.8$ fps<br>In 5.0 seconds $\Delta V = -100.9$ fps<br>Either EMS and/or DSKY may be used to read $\Delta V = -100.8$ fps which should be observed in $4.5 \pm 0.5$ seconds. $\Delta V$ and time should be monitored concurrently to determine which cue will prevail. The EMS should provide primary cue. |
| | 5 | Postsep pnl configuration | | During coast to transposition. Provides normal, safe, formation flight configuration. |
| CMP | | SM RCS PRPLNT tb (8) - gray (verify) | 2 | |
| | | SM RCS He tb (8) - gray (verify) | | |
| | | SM RCS SEC FUEL PRESS (4) - CLOSE | | Momentary. |
| LMP | | FC REAC VLVS - NORM | 3 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| LMP | 6 | Transposition | | |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>No TLI or propulsive venting not inhibited<br>Do NOT perform -X trans at 00:35<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | If TLI not performed or propulsive venting not inhibited, minimum separation distance at completion of pitch maneuver will be ≈65 feet. |
| CDR<br>00:35 | | THC -X to ΔV = -100.3 fps<br>MAN ATT PITCH - ACCEL CMD<br>RHC - pitch up 2°/sec<br>Visually acq SIVB & null pitch rate | 1 | Positive pitch at 2°/second followed by a negative pitch command to null rates at a total pitch maneuver of 180°. At completion of pitch maneuver, minimum separation distance will be ≈55 feet. |
| CMP | | V62E | 2 | Permits display of error between present and docking attitude on FDAI 1, N20 and N22. |
| CDR | | MAN ATT PITCH - RATE CMD<br>RHC, THC - Null trans err & rates<br>Perform auto roll mnvr to docking att, 4.8.3.4 | 1 | |
| | or | Perform man roll mnvr to docking att<br>CMC MODE - FREE<br>RHC - roll left 60° to null err needles | | |
| | 7 | HGA oper, 4.5.6.2 | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 8 | Set pnl 1 SCS att cont | | |
| CDR | | CMC MODE - FREE (verify) | 1 | |
| | | BMAG MODE (3) - ATT 1/RATE 2 | | |
| | | SC CONT - SCS | | |
| | 9 | Verify cont stat for docking | | |
| | | COAS PWR - on (up) | 15 | |
| CMP | | EXT RNDZ LT - SPOT | 2 | |
| | 10 | PROBE EXTD/REL - RETR (verify) | | Guarded. |
| | | PROBE EXTD/REL tb (2) - gray (verify) | | Verifies capture latches not locked. |
| | 11 | Init capture latch | | |
| CDR | | THC - translate to close at 0.25 to 0.5 fps maintain min lateral velocity | | Rate established visually. Use COAS and docking target for alignment cues. |
| | | RHC - maintain min relative align angles with SIVB | | |
| | | At contact, apply +X thrust as req | | Contact will be indicated by audio cues, a slight disturbance in motion, and/or COAS observation. |
| CMP | | PROBE EXTD/REL tb (2) - bp | | Talkbacks barber pole indicate capture. Only one talkback required for indication. Failure to capture will also be indicated by no noticeable rebound tension load (deceleration) and separation from SIVB. If retraction initiated, it will not occur until capture. |
| CDR | | SC CONT - CMC | 1 | |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>x x | | |
| CMP | | Positive ind of no capture or divergent oscillations or abnormal motions | | |
| | | PROBE EXTD/REL - EXTD/REL | 2 | Guarded. EXTD/REL position is momentary. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | SC CONT - SCS | 1 | |
| | | THC - -X withdraw to formation flt distance | | |
| CMP | | PROBE EXTD/REL - EXTD/REL for 5 sec | 2 | Guarded. EXTD/REL position is momentary. |
| | | PROBE EXTD/REL - RETR | | Guarded. |
| | | PROBE EXTD/REL tb - gray (verify) | | |
| | | Attempt redock as before | | |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | | Allow probe to damp SC motions (≈10 sec) | | |
| CDR | | THC - null pitch & yaw align err to within ±3° (min possible) | | Alignment determined using COAS and docking target. Retraction loads may cause docking ring damage. Loads are minimum at zero misalignment during retraction. |
| | | RHC - null roll align err to within ±10° | | Docking with roll angles >±10° may prohibit LM umbilical connection. |
| | 12 | Init retraction & docking latch closure | | |
| CMP | | PROBE RETR PRIM - 1 | | When capture latch alignment satisfactory. |
| | | Observe retraction movement between the two vehicles | | 10-inch retraction stroke should take ≈10 seconds. |
| | | PROBE EXTD/REL tb (2) - gray | | Talkback A will indicate only if docking latches 1, 5, and 9 close. Talkback B will indicate only if latches 3, 7, and 11 close. Audio and tactile cues will also indicate docking latch closure. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| CMP | | PROBE EXTD/REL tb (2) - remain bp after 30 sec & docking latch closure cues (auditory & tactile) unsatisfactory | 2 | |
| | | PROBE RETR PRIM - 2 | | |
| | | If docking still unsuccessful | | |
| | | PROBE RETR SEC - 1 | | |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | 13 | Safe docking sys | | |
| CDR | | SECS PYRO ARM (2) - SAFE | 8 | Lever lock. |
| | | SECS LOGIC (both) - OFF | | Lever lock. |
| | | cb SECS ARM (2) - open | | |
| | | EDS PWR - OFF | 7 | |
| | | cb EDS (3) - open | 8 | |
| CMP | | PROBE EXTD/REL - OFF | 2 | Guarded. |
| | | PROBE RETR (2) - OFF | | |
| CDR | | cb DOCK PROBE (2) - open | 8 | |
| | 14 | Postdocking pnl configuration | | |
| | | RATE - HI | 1 | |
| | | ATT DBD - MAX | | |
| | | cb RCS LOGIC (2) - open | 8 | |
| CDR | | TVC SERVO PWR (2) - OFF | 7 | |
| CMP | | EXT RNDZ LT - off (ctr) | 2 | |
| | | PRO | | |
| | | FL V37 | | |
| | | Key 00E | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | COAS PWR - OFF | 15 | |
| | EMS MODE - STBY | 1 | |
| | EMS FUNC - OFF | | |
| | BMAG MODE (3) - RATE 2 | | |
| CMP | TUNL LT - on (up) | 2 | |
| | Key V83E | | Checks state vector. |
| | Key V47E | | Moves LM state vector into CM state vector. |
| | 4.10.1.2 LM Ejection From SLA | | |
| 1 | The following are req | | |
| | Prep for LM withdrawal completed, 4.10.2.1 | | |
| | CMC - on, 4.8.1.3 | | |
| | SCS - on, 4.8.4.2 | | |
| | ISS - on & orientation known, 4.8.1.3 & 4.14 | | |
| | RCS DAP load & activated, 4.8.2.1 | | |
| | R1 - 21102 | | |
| | R2 - X1111 | | |
| 2 | Pre-LM ejection | | |
| CDR | cb DOCK PROBE (2) - close | 8 | |
| | Set Evnt Tmr 00:00 | 1 | |
| | cb SECS ARM (2) - close | 8 | |
| | After MSFN AOS | | |
| | SECS LOGIC (both) - on (up) | | Lever lock. |
| | Report logic arm | | |
| | After GO from MSFN | | |
| | SECS PYRO ARM (2) - on (up) | | Lever lock. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 3 | Perform ejection | | |
| LMP | | cb SIVB/LM SEP (2) - close (verify) | 278 | |
| CDR | | TVC SERVO PWR 1 - AC1/MNA | 7 | |
| | | EMS FUNC - ΔV SET | 1 | |
| | | SLEW ΔV ind - -100.0 | | |
| | | EMS FUNC - ΔV | | |
| | | EMS MODE - NORM | | Perform ≈30 seconds prior to ejection to minimize EMS drift error. |
| CMP<br>00:00 | | SIVB/LM SEP - on (up) | 2 | Guarded. On (up) position is momentary. |
| | | Start Evnt Tmr | | Spring system will provide a minimum separation velocity of ≈0.7 fps (assumes four actuators operated). |
| CDR<br>00:05 | | THC -X & hold | | |
| 00:08 | | THC - neut | | Provides a minimum separation velocity of ≈1.44 fps; or ≈1.38 fps if TLI is not performed or propulsive venting is not inhibited. The following tables provide parameters for flight planning if the variables (SIVB propulsive vent, time of RCS burn, etc.) are changed for specific missions. (See figure 4.10-1.) |
| 00:14 | | CMC MODE - AUTO | 1 | |
| | 4 | Postejection | | |
| | | SECS PYRO ARM (2) - SAFE | 8 | Lever lock. |
| | | SECS LOGIC (both) - OFF | | Lever lock. |
| | | cb SECS ARM (2) - open | | |
| LMP | | cb SIVB/LM SEP (2) - open | 278 | |

3 Sec CSM RCS Burn (400 Lb -X Translation)

| Configuration | SIVB Propulsive Vent Force (lbs) | Time to Translate 15 Ft (seconds) | | SIVB and CSM Recontact Time (No Evasive Mnvr) |
|---|---|---|---|---|
| | | RCS Burn at 5.0 to 8.0 Sec After Sep | RCS Burn at 8.0 to 11.0 Sec After Sep | |
| LM Ejection In Earth Parking Orbit | 0.0<br>8.0<br>12.5<br>25.0 | 16.3 sec<br>16.8 sec<br>17.2 sec<br>17.8 sec | 17.6 sec<br>18.6 sec<br>19.0 sec<br>20.2 sec | --<br>1280 sec<br>810 sec<br>400 sec |
| LM Ejection After TLI | 0.0<br>8.0<br>12.5<br>25.0 | 13.5 sec<br>14.0 sec<br>14.4 sec<br>15.6 sec | 14.4 sec<br>15.0 sec<br>15.5 sec<br>16.9 sec | --<br>375 sec<br>235 sec<br>115 sec |

No CSM RCS -X Translation

| Configuration | SIVB Propulsive Vent Force (lbs) | Time to Translate 15 Ft (secs) | SIVB and CSM Recontact Time (No Evasive Mnvr) |
|---|---|---|---|
| | | No RCS Burn | |
| LM Ejection In Earth Parking Orbit | 0.0<br>8.0<br>12.5<br>25.0 | 27.4 sec<br>36.3 sec<br>42.6 sec<br>61.3 sec | --<br>600 sec<br>362 sec<br>160 sec |
| LM Ejection After TLI | 0.0<br>8.0<br>12.5<br>25.0 | 16.6 sec<br>17.0 sec<br>17.5 sec<br>23.8 sec | --<br>237 sec<br>149 sec<br>62 sec |

Figure 4.10-1. SIVB/CSM Separation Parameters

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | LV IND/GPI sw - GPI | 1 | |
| | | CMC MODE - FREE | | When clear of SIVB. |
| | | MAN ATT (3) - MIN IMP | | |
| | | SC CONT - SCS | | |
| CMP | | Reload DAP | 2 | |
| | | N46, R1 = 21111 | | |
| CDR | | EMS MODE - STBY | 1 | |
| | | EMS FUNC - OFF | | |
| | | THC PWR - OFF | | |
| | | RHC PWR DIR (both) - OFF | | |
| | | RHC, THC - LOCKED | | |
| | | TVC SERVO PWR 1 - OFF | 7 | |
| | 4.10.1.3 | LM Undocking From CSM | | This procedure describes CSM activities required each time LM separates from CSM after docking except for final LM separation. These procedures as written are incomplete until properly integrated with corresponding LM procedures. |
| | 1 | Perform prep for manned LM sep, 4.10.2.4 | | |
| | 2 | Perform systems prep | | |
| | | SCS - on, 4.8.4.2 | | |
| | | Sel desired displays, 4.7.2 | | |
| | | Sel SCS rate damping only, 4.7.1.4 | | |
| | | cb DOCK PROBE (2) - close | 8 | |
| CMP | | PROBE EXTD/REL - RETR | 2 | Guarded. |
| | | PROBE EXTD/REL tb (2) - bp (verify) | | Verifies redundant probe retract capability. |
| | | PROBE EXTD/REL - OFF | | Guarded. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | MAN ATT (3) - RATE CMD<br>ATT DBD - MAX<br>RATE - HI<br>THC PWR - on (up)<br>RHC PWR NORM (both) - AC/DC<br>RHC PWR DIR (both) - MNA/MNB<br>RHC, THC - ARMED<br>SC CONT - SCS<br>BMAG MODE (3) - RATE 2 | 1 | |
| | 3 | Verify spacecraft status with LM | | CDR, LMP verify spacecraft status with CSM. |
| | 4 | Mnvr to sep att | | Per flight plan. Either vehicle may maintain attitude control. |
| | 5 | Perform fnl prep pnl operations | | |
| | | Set Evnt Tmrs<br>EVNT TMR RSET - DOWN | | Timer will be set up to reach 00:00 at separation. |
| -XX:XX | | EVNT TMR START - START (on sig from CDR) | | START position is momentary. |
| | 6 | Separation | | CDR will count down to separation time. |
| | | a. Undocking | | |
| | | CAUTION<br>PROBE EXTD/REL should not be held in EXTD/REL position longer than 20 sec if probe has not extended. Capability of capture latch rel mots may be degraded. | 2 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP<br>00:00 | PROBE EXTD/REL - EXTD/REL & hold until 5 sec after LM sep | 2 | Momentary up and guarded. Probe is extended by a compression spring and attenuator airhead forces. The 10-inch extension stroke working against CSM/LM inertia takes ≈5 seconds. |
| | PROBE EXTD/REL tb (2) - gray to bp to gray | | Barber pole indicates power to talkback through the probe circuitry. Return to gray indicates full extension of probe. |
| | Mon LM sep | | CDR will monitor CSM separation. The CSM and LM should attain a separation distance of 15 feet in 27 seconds with a separation velocity of 0.65 fps. Subsequent to 15-foot separation the LM may execute maneuvers with each vehicle configured as desired for attitude control. |
| | b. Soft Undocking (alternate) | | This procedure minimizes undocking ΔV. |
| | PROBE EXTD/REL - EXTD/REL (mom) | | Releasing switch from EXTD/REL position should be done as fast as possible in order to ensure that capture latches relock before probe gets fully extended. |
| | Probe extended & LM still attached (verify) | | LM motion should stop suddenly when probe gets fully extended resulting in both visual and tactile cues of probe extension and probe/drogue engagement. |
| | Allow motions to dampen (5 sec) | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | CAUTION<br>PROBE EXTD/REL should not be held in EXTD/REL position longer than 20 sec. Capability of capture latch rel mots may be degraded. | | |
| CMP<br>00:00 | | PROBE EXTD/REL - EXTD/REL & hold<br>After 2 sec<br>THC - -X (4 jet) for 1 sec | 2 | Guarded. EXTD/REL position is momentary. |
| | | PROBE EXTD/REL - OFF after probe/drogue disengagement verified | | Guarded. |
| | 7 | Postundocking reconfiguration<br>PROBE EXTD/REL - RETR | | Guarded. Required to provide capture latch talkback signal during subsequent docking. |
| | | PROBE EXTD/REL tb (2) - gray (verify) | | Verifies capture latches cocked. |
| | | PROBE EXTD/REL - OFF | | Guarded. |
| CDR | | cb DOCK PROBE (2) - open | 8 | |
| | | Prepare for contingency redocking | | |
| CMP | | EXT RUN/EVA LT - on (up) (verify) | 2 | |
| | | EXT RNDZ LT - RNDZ (verify) | | If required. |
| | | Activate rndz xpndr,<br>4.5.6.9 | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.10.1.4 LM Active Docking With CSM | | Describes CSM activities required each time LM docks with CSM. These procedures as written are incomplete until properly integrated with corresponding LM procedures. |
| | 1 | The following are req | | |
| CMP | | COAS - installed & calib, 4.14.1.8 | | |
| | | Docking trgt - installed & on | | |
| | 2 | Configure CSM for docking | | |
| CDR | | THC PWR - on (up) | 1 | |
| | | RHC PWR DIR (both) - MNA/MNB | | |
| | | SC CONT - CMC | | |
| | | CMC MODE - HOLD | | |
| | | BMAG MODE (3) - RATE 2 | | |
| | | AUTO RCS (16) - MNA or MNB | 8 | |
| | | MAN ATT (3) - RATE CMD | 1 | |
| | | THC - ARMED | | |
| CDR,CMP | | RHC (both) - ARMED | | |
| CDR | | ATT DBD - MIN | | |
| | | RATE - LO | | |
| | | EXT RUN/EVA LT - on (up) (verify) | 2 | If required. |
| | | COAS PWR - on (up) | 15 | |
| | | cb DOCK PROBE (2) - close | 8 | |
| | | PROBE RETR (2) - OFF | 2 | |
| | | cb SECS ARM (2) - close | 8 | |
| | | After MSFN AOS | | |
| | | SECS LOGIC (both) - on (up) | | Lever lock. |
| | | Report logic arm | | |
| | | After GO from MSFN | | |
| | | SECS PYRO ARM (2) - on (up) (verify) | | Lever lock. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | Confirm CSM status with LM | | |
| | | PROBE EXTD/REL - RETR (verify) | 2 | Guarded. |
| | | PROBE EXTD/REL tb (2) - gray (verify) | | Verifies capture latches are not locked. |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | | If PROBE EXTD/REL tb - bp | | |
| | | PROBE EXTD/REL - EXTD/REL for 5 sec | | Guarded. EXTD/REL position is momentary. |
| | | PROBE EXTD/REL - RETR | | Guarded. |
| | | PROBE EXTD/REL tb (2) - gray (verify) | | |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | 3 | Mon LM closing mnvrs | | LM will make final approach along +X axis at closing rates of 0.25 to 0.5 fps. |
| | 4 | Init capture latch & retraction | | |
| | | PROBE EXTD/REL tb (2) - mon | | Talkbacks barberpole indicates capture. Only one talkback is required for indication. Failure to capture will also be indicated by separation from the LM. If retraction is initiated it will not occur until capture. |
| | | PROBE EXTD/REL tb (2) - bp | | |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | | Positive ind of no capture | | |
| | | Advise LM no capture | | |
| | | THC - -X withdraw to formation flt distance | | |
| | | PROBE EXTD/REL - EXTD/REL for 5 sec | | Guarded. EXTD/REL position is momentary. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | PROBE EXTD/REL - RETR | 2 | Guarded. |
| | | PROBE EXTD/REL tb (2) - gray (verify) | | |
| | | Attempt redock as before | | |
| | | x xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx x | | |
| | | Confirm capture latch to LM | | |
| | | CMC MODE - FREE | 1 | |
| | | When LM aligned within ±3° | | |
| | | PROBE RETR SEC - 1 | 2 | Initiates probe retraction. The 10-inch retraction stroke should require ≈5 seconds. |
| | | PROBE EXTD/REL tb (2) - gray | | Talkback A will indicate only if docking latches 1, 5, and 9 close. Talkback B will indicate only if latches 3, 7, and 11 close. Audio and tactile cues also indicate docking latch closure. |
| | | x xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx x | | |
| | | PROBE EXTD/REL tb (2) - remain bp & docking latch closure cues (auditory & tactile) unsatisfactory | | |
| | | PROBE RETR PRIM - 2 | | |
| | | x xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx x | | |
| | 5 | Safe docking system | | |
| | | PROBE EXTD/REL - OFF | | Guarded. |
| | | PROBE RETR (2) - OFF | | |
| | | EXT RUN/EVA LT - OFF | | |
| | | EXT RNDZ LT - off (ctr) | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | COAS PWR - OFF | 15 | |
| | cb DOCK PROBE (2) - open | 8 | |
| | SECS PYRO ARM (2) - SAFE | | Lever lock. |
| | SECS LOGIC (both) - OFF | | Lever lock. |
| | cb SECS ARM (2) - open | | |
| | RNDZ XPNDR PWR - ORR | 100 | |
| 6 | Post docking operations prior to IVT | | LM will configure for inactive control status. |
| | CMC MODE - HOLD | 1 | |
| 4.10.1.5 | CSM Active Docking With LM | | Describes CSM activities required each time CSM docks with LM. These procedures as written are incomplete until properly integrated with corresponding LM procedures. |
| 1 | The following is req | | Range and range rate must be within docking limits. |
| | COAS - installed & calib, 4.14.1.8 | | |
| 2 | Configure CSM for docking | | SCS functions are for backup operation. |
| | THC PWR - on (up) | | |
| | RHC PWR DIR (both) - MNA/MNB | | |
| | SC CONT - SCS | | |
| | CMC MODE - FREE | | |
| | AUTO RCS (16) - MNA or MNB | 8 | |
| | MAN ATT (3) - RATE CMD | 1 | |
| | BMAG MODE (3) - ATT 1/RATE 2 | | Establishes SCS attitude hold. |
| | THC - ARMED | | |
| | RHC (both) - ARMED | | |
| | LIM CYCLE - OFF | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | ATT DBD - MIN | 1 | |
| | RATE - LO | | |
| | EXT RUN/EVA LT - on (up) (verify) | 2 | |
| | COAS PWR - on (up) | 15 | |
| | cb DOCK PROBE (2) - close | 8 | |
| | PROBE RETR (2) - OFF | 2 | |
| | cb SECS ARM (2) - close | 8 | |
| | After MSFN AOS | | |
| | SECS LOGIC (both) - on (up) | | Lever lock. |
| | Report logic arm | | |
| | After GO from MSFN | | |
| | SECS PYRO ARM (2) - on (up) | | Lever lock. |
| | PROBE EXTD/REL - RETR (verify) | 2 | Guarded. |
| | PROBE EXTD/REL tb (2) - gray (verify) | | Verifies capture latches not locked. |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>x x | | |
| | PROBE EXTD/REL tb (2) - bp | | |
| | PROBE EXTD/REL - EXTD/REL for 5 sec | | Guarded. EXTD/REL position is momentary. |
| | PROBE EXTD/REL - RETR | | Guarded. |
| | PROBE EXTD/REL tb (2) - gray | | |
| | x x<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| 3 | Init capture latch & retraction | | |
| | RHC, THC - align COAS with LM trgt | | |
| | THC - init +X to close at 0.25 to 0.5 fps | | Rate established visually. Use COAS and docking target for alignment cues. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | THC - maintain min lateral velocity<br>RHC - maintain min relative align angles with LM | | Contact will be indicated by audio cues, slight disturbance in motion and/or COAS observation. |
| | At contact, provide cue to LM for thrusting | | LM will apply +X thrusting as required on cue from CSM or by tactile cue at contact. |
| | PROBE EXTD/REL tb A and/or B - bp | 2 | Talkbacks barberpole indicate capture. Only one talkback required for indication. Failure to capture will also be indicated by separation from LM. If retraction initiated it will not occur until capture. |
| | Confirm capture latch to LM | | LM will terminate +X thrusting upon receipt of capture cue from the CSM. |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | Positive ind of no capture<br>THC - -X withdraw to formation flt distance | | |
| | PROBE EXTD/REL - EXTD/REL for 5 sec | | Guarded. EXTD/REL position is momentary. |
| | PROBE EXTD/REL - RETR | | Guarded. |
| | PROBE EXTD/REL tb - gray (verify)<br>Attempt redock as before | | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | SC CONT - CMC | 1 | |
| | Allow probe to damp SC motions (≈10 sec) | | |
| | THC - null pitch & yaw align to within ±3° | | Alignment determined using COAS and docking target. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | PROBE RETR SEC - 1 | 2 | Initiates probe retraction. 10-inch retraction should require ≈5 seconds. |
| | | Observe retraction movement between the two vehicles<br>PROBE EXTD/REL tb (2) - gray | | Talkback A will indicate only if docking latches 1, 5, and 9 close. Talkback B will indicate only if latches 3, 7, and 11 close. Audio and tactile cues will also indicate docking latch closure. |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>PROBE EXTD/REL tb (2) - remain bp & docking latch closure cues (auditory & tactile) unsatisfactory<br>PROBE RETR PRIM - 2<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | 4 | Safe docking system | | |
| | | PROBE EXTD/REL - OFF | | Guarded. |
| | | PROBE RETR (2) - OFF | | |
| | | EXT RUN/EVA LT - OFF | | |
| | | EXT RNDZ LT - off (ctr) | | |
| | | COAS PWR - OFF | 15 | |
| | | cb DOCK PROBE (2) - open | 8 | |
| | | SECS PYRO ARM (2) - SAFE | | Lever lock. |
| | | SECS LOGIC (both) - OFF | | Lever lock. |
| | | cb SECS ARM (2) - open | | |
| | | RNDZ XPNDR PWR - OFF | 100 | |
| | 5 | Postdocking operations prior to IVT | | |
| | | CMC MODE - HOLD | 1 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 4.10.1.6 | LM Jettison and Separation | | |
| | 1 | Perform fnl IVT to CSM, 4.10.2.3 | | |
| | 2 | Perform auto mnvr to jett att, 4.8.3.4 | | R62. |
| | or | Perform SCS att mnvr to jett att, 4.8.4.5 | | |
| | 3 | Perform tunl depressurization & fwd hatch seat integrity check, 4.10.2.4, step 5 | | |
| | 4 | Perform LM jett prep | | |
| CMP | | LM PWR - OFF (verify) | 2 | |
| CDR | | cb SECS ARM (2) - close | 8 | |
| | | After MSFN AOS | | |
| | | SECS LOGIC (both) - on (up) | | Lever lock. |
| | | Report logic arm | | |
| | | After GO from MSFN | | |
| | | SECS PYRO ARM (2) - on (up) | | Lever lock. |
| | | At jett att | | |
| | | BMAG MODE (3) - ATT 1/RATE 2 | 1 | |
| | | SC CONT - SCS | | |
| CMP | | RCS DAP - load & actuate, 4.8.2.1 | | |
| | | R1-11102 (N46 display) | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 5 | LM jett<br>CSM/LM FNL SEP (both) - on (up) | 2 | Guarded and momentary. Provides jettison of docking ring, with probe and LM attached, from CSM. Separation velocity of 0.4 ft/sec will be obtained with the use of the docking ring pyrotechnic separation device only (CM/LM tunnel depressurized). If four quads RCS firing is used to augment $\Delta V$, 1.44 pounds of propellants are used for every second of firing. Any pressure in CM/LM tunnel at time of separation will impart an additional $\Delta V$ up to a maximum of 1.9 ft/sec. |
| | 6 | Postjett pnl reconfiguration | | |
| CDR | | SECS PYRO ARM (2) - SAFE | 8 | Lever lock. |
| | | SECS LOGIC (both) - OFF | | Lever lock. |
| | | cb SECS ARM (2) - open | | |
| | 7 | Separation | | |
| | | Perform SCS att mnvr to sep att, 4.8.4.5 | | |
| | or | Perform auto mnvr to sep att, 4.8.3.4 | | R62. |
| | | Mon G&N thrusting, 4.8.1.6 | | P47. |
| | | EMS MODE - NORM | 1 | |
| | | THC - +Z (2 jet) for 1.0 fps $\Delta V$ (5 sec min after pyro sep) | | |

## 4.10.2 IVT

This section provides data which apply to all intervehicular crew transfers during the CSM mission. Because a transfer to the LM or to the CM is basically the same, only a few procedures are provided to cover all the intervehicular transfers involved in the mission. As is the practice throughout the J-Series Volume II AOH, the column heading STA/T refers to the spacecraft location where a procedure or step is performed except for those times when a crewman has transferred to the LM. In this case, the STA/T heading is used to refer directly to the corresponding crewman and not to the spacecraft location.

### 4.10.2.1 Preparation for LM Ejection

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| ALL | 1 | Configure PGAs, 4.5.4.6b | | |
| CMP | | Retrieve & don helmet protective shield | | |
| | 2 | Configure couches as req | | |
| | 3 | Configure cont pnl | | |
| | | LM PWR - OFF (verify) | 2 | |
| | | TUNL LT - on (up) | | |
| | 4 | Perform docking tunl operations | | Tunnel pressure integrity incorporated in CM/LM pressure equalization procedure. |
| | | Equalize CM/LM press, 4.5.4.14 | | |
| | | Remove fwd hatch, 4.5.7.4a | tunl | |
| | | Verify docking latches | | |
| | | Pull latch handle of each latch to ensure hook is engaged | | Latch indicator button (red) may protrude through hole in latch handle if latch is not engaged. |
| | | Pwr bungee parallel to +X axis (verify) | | |

IVT

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| CMP | | If hook(s) not engaged<br>Attempt to engage latch handle prior to recocking latch<br>If pwr bungee not parallel to +X axis<br>Push on top of bungee fairing to obtain fnl preload<br>If hook(s) cannot be engaged or pwr bungee parallel to +X axis not attained<br>Recock latch(es) & man trigger, 4.10.4.8, steps 2 & 4 | tunl | |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | | Depress GN2 bleed button (red) at aft end of probe body & hold for 10 sec | | Required to bleed probe retract gas system for subsequent operation. |
| | | Connect LM umb conn (2)<br>Open docking ring conn fairings (2) (orange) | | |
| | | Disengage one conn from stowage receptacle in LM tunl<br>Pull umb across docking interface<br>Align index marks<br>Push LM umb conn into pwr receptacle in docking ring & rot CW to lock | | One at a time. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | Route LM umb thru slot in back of receptacle assy & close fairing (orange) | tunl | Fairing must be closed to install hatch. |
| | | Repeat for sec umb | | |
| | | LM PWR - CSM | 2 | |
| | | SYS TEST (2) - 7D | 101 | Test for integrity of electrical umbilical connection. |
| | | SYS TEST ind - 0.5-3.2 vdc (1-6.4 amps) | | |
| | | Reinstall fwd hatch, 4.5.7.5 | | |
| ALL | 5 | Reconfigure couches as req | | |
| | 4.10.2.2 | IVT to LM | | Procedure describes general requirements for crew transfer to LM under normal conditions. Not all steps included here are necessarily required for every IVT; utilization depends on particular time in mission when transfer occurs. Procedures as written are incomplete until properly integrated with corresponding LM procedures. |
| | 1 | The following are req | | |
| CDR,LMP | | PGAs configured, 4.5.4.6d | | |
| CMP | | PGA - configured, 4.5.4.6b | | |
| | | Retrieve & don helmet protective shield | | |
| | | Couches configured as req | | |
| | 2 | Clear tunl | | |
| | | TUNL LT - on (up) | 2 | |
| | | Equalize CM/LM press, 4.5.4.14 | | Tunnel pressure integrity check included as part of CM/LM pressure equalization procedure. |
| | | Remove fwd hatch, docking probe, & docking drogue, 4.5.7.4a, 4.10.4.1, & 4.10.4.4 | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 3 | Crew Transfer | | LMP umbilical hoses used as transfer hoses. Transfer umbilical hoses must be hooked up to left PGA connectors before transferring. |
| LMP | | Connect trnfr 02 hose to left PGA conn (2) | | Red to red, blue to blue. |
| | | rh SUIT FLOW vlv - FULL FLOW | 300 | |
| | | Connect protective plugs to right PGA conn (2) | | |
| | | Trnfr to LM head first entering LM cabin facing fwd | | |
| CMP | | Audio pnl sw (all) - as desired by LMP | 6 | LMP will perform initial entry status check, partial activation of systems and checkout. |
| CDR | | LM PWR - OFF (upon coordination with LMP) | 2 | |
| CMP | | rh SUIT FLOW vlv - OFF (upon request from LMP) | 300 | LMP will connect to LM ECS and perform VHF activation and checkout. |
| | | Upon request from LMP<br>PWR - OFF<br>SUIT PWR - OFF<br>AUDIO CONT - FORM | | |
| | | | | LMP will disconnect transfer umbilicals. |
| CDR | | Obtain umbs from LMP | | |
| CMP | | ctr SUIT FLOW vlv - CAB FLOW | 302 | |
| CDR | | Connect 02 trnfr umb to left PGA conn (2) | | Red to red, blue to blue. |
| | | rh SUIT FLOW vlv - FULL FLOW | 300 | |
| | | Disconnect 02 hose from right PGA conn (2) | | |
| | | Connect protective plugs to right PGA conn (2) | | |
| | | Install interconnect on 02 hose (CDR's) | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | PWR - OFF<br>SUIT PWR - OFF<br>AUDIO CONT - NORM | 9 | |
| CDR | | Remove CCU from PGA conn | | |
| CMP | | Verify PWR & SUIT PWR sws on LMP's audio pnl are in OFF position | 6 | |
| CDR | | Connect trnfr CCU to PGA | | |
| CMP | | Audio pnl sw (all) - as desired by CDR | | |
| CDR | | Trnfr to LM head first entering LM cab facing fwd | | |
| | | Upon request from CDR | | CDR will hook up 02 umbilical. |
| CMP | | rh SUIT FLOW vlv - OFF | 300 | CDR will verify 02 flow to PGA from LM ARS and perform VHF activation and checkout. |
| | | PWR - OFF<br>SUIT PWR - OFF | 6 | CDR will disconnect transfer umbilical comm cable from PGA and connect LM comm cable to PGA when headset sounds cease. |
| | | Obtain trnfr umbs | | |
| | | Install suit hose interconnect on 02 hoses | | |
| | | Stow trnfr umbs | | |
| | 4 | Close tunl (docking hardware stowage) | | Step to be performed when other than temporary stowage in CM cabin required for mission phases such as DPS, docked burn, and EVA. |
| | | Install docking drogue, docking probe, & fwd hatch, 4.10.4.6, 4.10.4.3 & 4.5.7.5 | | |
| | | TUNL VENT vlv - LM/CM $\Delta P$ | 12 | |

IVT

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.10.2.3 IVT to CSM | | |
| | 1 | The following are req | | |
| ALL | | PGAs configured as req | | |
| CMP | | Retrieve & don helmet protective shield if req | | |
| | | Couches configured as req | | |
| | 2 | Clear tunl | | |
| | a. | Prior to LOD | | This is the normal procedure for returning to the CSM prior to LOD. |
| | | CM/LM Press Equalization, 4.5.4.14 | | |
| | | Remove fwd hatch, docking probe, & docking drogue, 4.5.7.4a, 4.10.4.1, & 4.10.4.4 | | |
| | | Equalize tunl/LM press & open LM hatch | | |
| | b. | After LOD or emergency | | Normal procedure for returning to CSM after LOD and would be used for an emergency return without assistance from CSM. |
| | | Equalize LM/tunl press from LM | | |
| | | Remove docking drogue & docking probe, 4.10.4.5 & 4.10.4.2 | | |
| | | Stow probe & drogue in LM as req | | |
| | | CM/LM Press Equalization, 4.5.4.14, if req | | |
| | | Remove fwd hatch, 4.5.7.4 | | Procedure of 4.5.7.4b would be performed only if CMP could not perform 4.5.7.4a. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 3 | Crew Transfer | | |
| | | a. From LM ECS | | The procedure as written assumes that CDR normally makes transfer first. If LMP transfers first, it will be necessary for LMP and CDR to trade umbilicals. |
| | | rh SUIT FLOW vlv - as desired (verify) | 300 | |
| | | Connect hose interconnect to trnfr umbs (verify) | | |
| | | PWR - OFF (verify) | | |
| | | SUIT PWR - OFF (verify) | | |
| | | AUDIO CONT - NORM (verify) | | |
| | | Pass trnfr umbs to LM | | LM crewman will connect transfer 02 and comm umbilicals to PGA. |
| | | Upon request from LM crewman (via VHF) | | |
| | | rh SUIT FLOW vlv - FULL FLOW | 300 | |
| | | PWR - AUDIO/TONE | 6 | |
| | | SUIT PWR - on (up) | | |
| CDR,LMP | | Trnfr to CSM | | |
| | | Remove protective plugs from right PGA conn (2) | | |
| | | Remove suit hose interconnect from 02 hoses (CDR's) | | |
| | | Connect 02 umb (CDR's) to right PGA conn (2) | | Red to red, blue to blue. |
| | | lh SUIT FLOW vlv - FULL FLOW | 301 | |
| | | rh SUIT FLOW vlv - OFF | 300 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR,LMP | Disconnect LMP's 02 hose from left PGA conns | | |
| | Connect protective plugs to left PGA conns | | |
| | Install suit hose interconnect on 02 hoses (trnfr) | | |
| CMP | PWR - OFF | 6 | |
| | SUIT PWR - OFF | | |
| | AUDIO CONT - NORM (verify) | | |
| CDR,LMP | Remove trnfr CCU from PGA conn | | |
| CMP | Verify PWR & SUIT PWR sws on CDR's audio pnl are in OFF position & AUDIO CONT sw in NORM position | 9 | |
| CDR,LMP | Connect CDR's (left) CCU to PGA | | |
| CMP | Audio pnl sw (all) - as desired | | |
| CDR,LMP | rh SUIT FLOW vlv - OFF (verify) | 300 | |
| | Connect hose interconnect to trnfr umbs (verify) | | |
| | PWR - OFF (verify) | | |
| | SUIT PWR - OFF (verify) | | |
| | AUDIO CONT - NORM (verify) | | |
| | | | LM crewman will connect transfer 02 and CCU umbilicals to PGA. |
| | Pass trnfr umbs to LM | | |
| | Upon request from LMP/CDR | | |
| CMP | rh SUIT FLOW vlv - FULL FLOW | 300 | |
| | PWR - AUDIO/TONE | 6 | |
| | SUIT PWR - on (up) | | |
| | | | LM vehicle power down.<br>If required. |
| | LM/CSM pwr trnfr | | |
| | Upon request from LMP | | |
| | LM PWR - CSM | 2 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP,CDR | Trnfr to CSM | | |
| | b. From PLSS/OPS & LM ECS | | CDR and LMP are in LM, one crewman on LM ECS, one crewman on PLSS/OPS. LMP transferred first in these procedures because of operational considerations (i.e., amount of oxygen available in PLSS/OPS, etc.). It will be necessary for LMP and CDR to trade umbilicals once transfer completed. |
| CMP | rh SUIT FLOW vlv - OFF (verify)<br>PWR - OFF (verify)<br>SUIT PWR - OFF (verify)<br>AUDIO CONT - NORM (verify) | 300 | |
| | | | LM crewman will open LM hatch and secure. |
| | Pass trnfr umbs to LM | | LM crewman on PLSS/OPS will connect transfer 02 and comm umbilicals to PGA. |
| | rh SUIT FLOW vlv - as desired LM crewman | | |
| | Upon request from LM (via VHF)<br>PWR - AUDIO/TONE<br>SUIT PWR - on (up) | 6 | |
| | | | LM crewman will transfer through tunnel to CM. |
| LMP,CDR | lh SUIT FLOW vlv - OFF (verify)<br>Remove protective plugs from left PGA conn (2) | 301 | |
| | Connect 02 umb (CDR's) to left PGA conn (2) | | Red to red, blue to blue. |
| | lh SUIT FLOW vlv - FULL FLOW | | |
| | rh SUIT FLOW vlv - OFF | 300 | |
| | Disconnect 02 trnfr umbs from right PGA conn (2) | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| LMP,CDR | Connect protective plugs to right PGA conns | | |
| | Install interconnect on 02 hose | | |
| CMP | PWR - OFF | 6 | |
| | SUIT PWR - OFF | | |
| | AUDIO CONT - NORM (verify) | | |
| | PWR - OFF (verify) | 9 | |
| | SUIT PWR - OFF (verify) | | |
| | AUDIO CONT - NORM (verify) | | |
| | Remove trnfr CCU from PGA | | |
| | Audio pnl sw (all) - as desired | | |
| | rh SUIT FLOW vlv - OFF (verify) | 300 | |
| | Connect hose interconnect to trnfr umbs (verify) | | |
| | PWR - OFF (verify) | 6 | |
| | SUIT PWR - OFF (verify) | | |
| | AUDIO CONT - NORM (verify) | | |
| | Pass trnfr umbs to LM | | |
| | | | LM crewman will connect transfer 02 and CCU umbilicals to PGA. |
| | Upon request from CDR/LMP | | |
| LMP,CDR | rh SUIT FLOW vlv - FULL FLOW | 300 | |
| CMP | PWR - AUDIO/TONE | 6 | |
| | SUIT PWR - on (up) | | |
| | | | LM vehicle power down. |
| | LM/CSM pwr trnfr | | If required. |
| | Upon request from LM crewman | | |
| | LM PWR - CSM | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR,LMP | | Trnfr to CSM | | |
| | | Install docking drogue, docking probe, & fwd hatch, 4.10.4.6, 4.10.4.3, & 4.5.7.5 | | If required. |
| | 6 | Close tunl (docking hardware stowage), prior to LOD only | | |
| | | Install docking drogue, docking probe, & fwd hatch, 4.10.4.6, 4.10.4.3, & 4.5.7.5 | | |
| CMP | | TUNL VENT vlv - LM PRESS | 12 | |
| | 4.10.2.4 | Preparation for Manned LM Separation | | |
| | 1 | Complete crew trnfr to LM, 4.10.2.2 | | |
| | 2 | Remove LM umbs | | |
| | | LM PWR - OFF | | |
| | | Open docking ring conn fairings (2) (orange) | tunl | |
| | | Pull conn shell inbd & rot CCW to unlock | | |
| | | Pull conn inbd to disengage from receptacle | | |
| | | Repeat for sec umb | | |
| | | Close docking ring conn fairings (2) (orange) | | |
| | | Pull lanyard on LM end of umb | | Connector lanyard located behind flat panel near LM hatch. |
| | | Remove umb from tunl & stow in CM | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 3 | Install tunl hardware | | |
| | | Install docking drogue & docking probe, 4.10.4.6 & 4.10.4.3 | | |
| | 4 | Preload probe & disengage docking latches | | |
| | | Preload docking probe, 4.10.4.7 | | |
| | | CAUTION<br>Verify that CSM RCS roll commands are inhibited before disengaging docking latches. Roll commands may be initiated after cab/tunl $\Delta P \geq 3.5$ psid. | | Firing the RCS roll thrusters with latches disengaged and cabin/tunnel $\Delta P < 3.5$ psid may result in docking interface slippage. |
| | | Disengage docking latches, 4.10.4.8, steps 1 thru 3 | | |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>x x | | |
| CMP | | Master alarm tone sounds | | |
| | | Re-engage/verify 3 docking latches ≈120° apart are engaged, 4.10.4.8, step 4 | tunl | |
| | | Determine O2 FLOW HI lt - on | 2 | |
| | | MASTER ALARM pb/lt - on (push) | 122 | |
| | | Use tool F to drive hex fitting on aft end of preload handle 180° max in CW direction | tunl | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | Torque preload handle CW until load limiter releases<br>Cock engaged docking latches, 4.10.4.8, steps 1-3<br>Master alarm tone does not sound<br>Proceed with the procedure (step 5) | | |
| | | or Master alarm tone sounds<br>Install fwd hatch, 4.5.7.5<br>Proceed with the procedure deleting step 5 (secure tunl hatches & check integrity) | | Suit may balloon. |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | 5 | Secure tunl hatches & check integrity<br>Install fwd hatch, 4.5.7.5<br>Verify LM hatch is closed & vlv properly set | | LM function. |
| CMP | | CAB PRESS ind - 4.7-5.3 psia (verify) | 2 | |
| | | Read 02 FLOW ind | | |
| | | TUNL VENT vlv - TUNL VENT for 30 sec, then LM/CM ΔP & check ΔP incr | 12 | |
| | | TUNL VENT vlv - TUNL VENT until ΔP >3.5 psi | | |
| | | LM/CM ΔP ind - remains constant within ±0.2 psi at least value read for 2 min (verify) | | |
| | | 02 FLOW ind - no incr (verify) | 2 | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | 02 FLOW ind - incrs and/or LM/CM ΔP ind - ΔP decr | 12 | |
| | 02 FLOW ind remains stable, LM hatch is probably not integral - advise LM crew | 2 | |
| | 02 FLOW ind - incrs, CM fwd hatch is probably not integral | | |
| | Pressurize tunl using PRESS EQUAL vlv | Fwd hatch | |
| | Open fwd hatch, 4.5.7.4a | | |
| | Check for foreign object(s) jammed in tunl/hatch seal interface or hatch seal damage | | |
| | Close fwd hatch, 4.5.7.5 | | |
| | Reinitiate step 5 (secure tunl hatches & check integrity) | | |
| | For undocking only | | |
| | TUNL VENT vlv - TUNL VENT for 10 min, then | 12 | Required to vent tunnel pressure to zero to allow LM RCS 4-jet yaw or CSM RCS 4-jet roll maneuvers. During LM RCS jet test firings, CSM roll attitude control will be disabled. |
| | TUNL VENT vlv - LM/CM ΔP | | |
| | LM/CM ΔP ind - >4 psid (pegged) | | |
| | TUNL VENT vlv - OFF | | |
| | TUNL LT - OFF | 2 | |
| | For jett only | | |
| | TUNL VENT vlv - TUNL VENT for 10 min | 12 | |
| | TUNL LT - OFF | 2 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | 6 | Configure cab for sep<br>Remove ctr couch & stow<br>Install docking trgt & receive alignment verification from LM<br>Configure side hatch for unaided ingress<br>Actr handle sel - N (neut)<br>Vent counterbalance piston chamber<br>GN2 vlv handle - pull (inbd)<br>GN2 press ind - min | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.10.3 EXTRAVEHICULAR ACTIVITY (EVA) | | |
| | | 4.10.3.1 CSM/LM EVA | | |
| | 1 | CSM Prep | | |
| | | Configure PGA as desired, 4.5.4.6 | | |
| | | Configure couches as req | | |
| | | Disable desired RCS jets (Quad A) | | |
| CDR | | AUTO RCS A/C ROLL A1, A2 (2) - OFF | 8 | |
| | | AUTO RCS B/D ROLL (4) - OFF | | |
| | | AUTO RCS PITCH A3, A4 (2) - OFF | | |
| | | AUTO RCS YAW B3, D4 (2) - OFF | | |
| CMP | | Verify side hatch counterbalance mechanism is disengaged, 4.5.7.3a (if desired) | | |
| | | Reconfigure PGA, 4.5.4.6b | | |
| | | PLSS comm check if req on request by LM | | |
| LMP | | VHF AM A - DUPLEX | 3 | |
| | | VHF AM B - off (ctr) (verify) | | |
| | | VHF RNG - OFF (verify) | | |
| | | Verify comm with | | |
| | | 2 PLSS - CDR (EVCS #1) & LMP (EVCS #2) | | |
| | | or 1 PLSS - EVCS #1 or EVCS #2 | | |
| | | Suit circuit & PGA integrity check, 4.5.4.9a | | |
| | | Dump CM press, 4.5.4.11 | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 2 | Side Hatch Operation | | |
| | | WARNING<br>The hatch should not remain in the open position and exposed to worst conditions for longer than 60 min as warpage may occur & make the hatch difficult to close. | | |
| CMP | a. | From CM Interior<br>Open side hatch, 4.5.7.1a or b<br>Close side hatch, 4.5.7.2a | | The particular method and crewmen involved in opening the hatch optional (by crew coordination per flight plan). |
| LMP | or b. | From CM Exterior<br>Open side hatch, 4.5.7.1c | | |
| CMP,<br>LMP | or c. | From CM Interior/Exterior<br>Close side hatch, 4.5.7.2b | | |
| | 3 | Vacuum Trnfr to CSM ECS | | |
| | a. | From LM ECS<br>Perform trnfr, 4.10.2.3-6 | | |
| | b. | From OPS & PLSS/OPS | | All crewmen in CM, CDR on OPS, LMP on PLSS/OPS. Although these procedures are written sequentially, actual transfers of CDR and LMP to CSM ECS may be performed concurrently depending upon operational considerations (i.e., amount of oxygen remaining in OPS and PLSS/OPS, other time constraints, etc.). CDR and LMP assist each other as required. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CDR | lh SUIT FLOW vlv - OFF (verify) | 301 | |
| CMP | PWR - OFF (verify) | 9 | |
| | SUIT PWR - OFF (verify) | | |
| | AUDIO CONT - NORM (verify) | | |
| CDR | Remove PGA conn thermal covers | | |
| | Connect 02 umb (CDR's) to right PGA conns | | Red to red, blue to blue. |
| | lh SUIT FLOW vlv - FULL FLOW | 301 | |
| | OPS 02 shutoff vlv - close | | |
| | Close purge vlv in left PGA outlet conn | | |
| | Connect CCU (CDR's) to PGA | | |
| | Audio pnl sw (all) - as desired | 9 | |
| LMP | rh SUIT FLOW vlv - OFF (verify) | 300 | CDR positioned nearest suit flow valves. |
| CMP | PWR - OFF (verify) | 6 | LMP may perform these operations depending upon his position in CM. |
| | SUIT PWR - OFF (verify) | | |
| | AUDIO CONT - NORM (verify) | | |
| LMP | Remove PGA conn thermal covers | | |
| | Remove purge vlv from right PGA outlet conn | | This operation should be deferred until CM repressurized if operationally feasible. |
| | OPS 02 shutoff vlv - close | | |
| | Disconnect OPS 02 hose from right PGA inlet conn | | |
| | Connect 02 umb (LMP's) to right PGA conns | | Red to red, blue to blue. |
| CDR | rh SUIT FLOW vlv - FULL FLOW | 300 | |
| LMP | PLSS FAN sw - OFF | PLSS | |
| | PLSS 02 SHUTOFF vlv - CLOSE | | |
| | PLSS PUMP sw - OFF | | |
| | PLSS MODE SELECTOR sw - OFF (position 3) | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| LMP | | Disconnect PLSS elect umb from PGA | PLSS | |
| | | Connect CCU (LMP's) to PGA | | |
| | | Audio pnl sw (all) - as desired | 6 | |
| ALL | 4 | CSM POST-EVA Reconfiguration<br>Repressurize CM, 4.5.4.8a or 4.5.4.8b | | |
| | | Reconfigure couches as req | | |
| | 4.10.3.2 | Scientific Instrumentation Module (SIM) EVA | | These are integrated operations requiring coordination with OPS procedures. |
| | 1 | System Prep | | Assumes all experiments have been deactivated and those requiring retraction have been retracted (4.18.3.2, 4.18.3.4, 4.18.3.6, & 4.18.4.2). |
| | | CMC - on (req), 4.8.1.3<br>ISS - on & orient known (req), 4.18.1.3 & 4.14<br>SCS - on (desired), 4.8.4.2<br>RCS DAP - load & activate (req), 4.8.2.1 | | Deadband recommended 5°. Select A/C for roll control to be compatible with step 12 jet disable configuration. |
| | 2 | Mnvr to EVA att<br>P___° Y___° R___° | | Provides best lighting on SIM. |
| | 3 | Configure couches as req | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| LMP, CDR | 4 | Don PGAs with 02 umb conns reversed | | 02 umbilical reversed for optimum flow distribution within PGA. |
| | | SUIT FLOW vlv - FULL FLOW | 300,301 | |
| | 5 | Configure PGA for EVA | | |
| CMP | | Don PGA | | LMP assist as required. |
| LMP | | SUIT PWR - OFF | 10 | |
| | | PWR - OFF | | |
| | | AUDIO CONT - NORM | | |
| | | Conn EVA 02/comm umb to CM IVA/EVA sta | 603 | |
| | | Conn EVA 02/comm umb to PGA | PGA | |
| | | Attach OPS & OPS PURGE vlv | | |
| | | Attach SUIT CONT vlv | | |
| | | Attach PRESS CONT vlv | | |
| | 6 | Configure audio ctr | | |
| | | SUIT PWR - on (up) | 10 | |
| | | PWR - AUDIO | | |
| | | MODE - INTERCOM/PTT | | |
| | | S BD - T/R | | |
| | | INTERCOM - T/R | | |
| | | PAD COMM - OFF | | |
| | | VHF AM - OFF | | |
| | 7 | Checkout OPS, PGA, & EVA 02 umb | | |
| CMP | | Don helmet & gloves | | |
| | | OPS checkout per decal | | Refer to orbital EVA Procedures document prepared by EVA Branch FCSD, MSC. |
| | | PGA & EVA 02 umb checkout | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CDR | | EVA STA 02 SUP - ON | 603 | |
| | | SUIT PRESS ALARM - ON | 604 | |
| | | PCV - open | PGA | |
| | | SCU - open | | |
| | | Mon suit tonal alarm | | Automatic shutoff occurs at suit pressure indication of 3.1-3.4 psig. |
| | | Mon PGA press incr | Cuff gage | |
| | | SUIT PRESS ind - 3.5-4.0 psig | | |
| | | Tonal alarm - off | | |
| | | SUIT PRESS ind - stable at 3.5-4.0 psig | | |
| | | WARNING<br>SCU vlv may remain in close position for no longer than one min or asphyxiation may result. | | |
| | | SCU - close | PGA | |
| | | Mon SUIT PRESS ind for <0.3 psi/min press decay | | |
| | | SCU - open | | |
| LMP,<br>CDR<br>CMP | 8 | Configure for CM Depressurization | | |
| | | Configure PGA, 4.5.4.6b | | |
| | | ctr SUIT FLOW vlv - OFF (EVA crewman only) | 302 | |
| | | Install 02 umb interconnect | | |
| LMP | 9 | Activate prim evap | | To facilitate water removal in the suit circuit and preclude LMP and CDR face plate fogging. |
| | | GLY EVAP H20 FLOW - AUTO | 2 | |
| | | GLY EVAP STM AUTO - AUTO | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| LMP,<br>CDR | 10 | Perform suit ckt integrity check, 4.5.4.9 | | |
| CDR | 11 | Perform CM press dump, 4.5.4.11a (except rh CAB PRESS RELF vlv - DUMP at conclusion of dump) | 325 | To preclude pressure buildup in CM because of purge flow from returning EVA crewman, the CAB PRESS RELF vlv must remain open. |
| | 12 | Deactivate SM RCS<br>AUTO RCS A/C ROLL A1 & A2 - OFF<br>AUTO RCS B/D ROLL B1 & B2 & D2 - OFF<br>AUTO RCS PITCH A3 & A4 - OFF<br>AUTO RCS YAW B3 & B4 - OFF | 8 | |
| | 13 | Side Hatch Oper (open)<br>WARNING<br>The side hatch should not remain in open position & exposed to worst case conditions for longer than 60 min as warpage may occur & make hatch difficult to close.<br>Open side hatch, 4.5.7.1a | | The particular method and crewman involved in opening hatch is optional. Flight plan coordination is required. |
| CMP | 14 | EVA to SIM | | Use CM/SM handrails and Dutch slippers. Refer to orbital EVA Procedures document for approach to SM and film cassette removal. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | | If PGA press alarm tone sounds or loss of purge flow | | |
| CMP | | OPS shutoff vlv - open | PGA | |
| | | PURGE vlv - HI FLOW | | |
| | | SUIT PRESS ind - >3.4 psig | Cuff gage | |
| | | SCU - close | PGA | |
| | | PCV - close | | |
| | | If SUIT PRESS ind - <3.4 psig | | |
| | | SCU - open | | |
| | | SUIT PRESS still <3.4 psig | | |
| | | PURGE vlv - LO FLOW | | |
| | | Ingress CM immediately | | |
| | | Helmet & gloves can be removed at CM PRESS ind - 3.0 psi if req | | |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | 15 | Side Hatch Oper (close) | | |
| | | Close side hatch, 4.5.7.2a | | |
| | 16 | CM Post - EVA reconfiguration | | |
| | | Repressurize CM, 4.5.4.8a | | |
| | | Reconfigure couches as req | | |
| ALL | 17 | Remove PGAs & stow | | |
| | 18 | Deactivate EVA sta | | |
| CDR | | EVA STA 02 SUP - OFF | 603 | |
| | | SUIT PRESS ALARM - OFF | 604 | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 19 | Deactivate prim evap | | |
| LMP | | GLY EVAP H20 FLOW - off (ctr) | 2 | |
| | | GLY EVAP STM AUTO - MAN | | |
| | | GLY EVAP STM INCR - INCR for 58 sec min | | INCR position is momentary. Steam pressure valve requires 58 seconds from full open to full close. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | 4.10.4 TUNNEL MECHANICAL SYSTEMS | | |
| | | 4.10.4.1 Docking Probe Removal (CM side) | | |
| | 1 | Pnl & tunl configuration | | |
| CMP | | PROBE (3) - OFF | 2 | PROBE EXTD/REL switch is guarded. |
| | | cb DOCK PROBE (2) - open | 8 | |
| | | Fwd hatch removed, 4.5.7.4 | | |
| | | Auto docking latches engaged (at least 3 engaged latches ≈120° apart) | tunl | |
| | 2 | Extend latch engaged, ind (red) not visible (verify) | | If probe is being removed after previously being Installed for stowage, it will not be necessary to perform steps 2, 3, and 4. Step 2 should be performed only after TLD. |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>If extd latch is not engaged, ind (red) not flush with latch housing<br>Preload sel lever - rot CW (away from orange stripe)<br>Preload handle - torque CCW until extd latch engages, ind (red) not visible<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | GN2 bleed button (red) - press for 10 sec | tunl | GN2 bleed button (red) located under pyro components cover, depressurizes probe retract system when depressed. |
| | Preload sel lever - rot CCW (parallel to orange stripe) | | |
| | Preload handle - torque CW until load is removed from support beams | | Support beams may become loose in docking ring sockets. |
| 3 | Preload sel lever - rot CW (away from orange stripe) | | Step 3 should be performed only after LOD. |
| | Preload handle - torque CCW until extd latch engages, ind (red) not visible | | |
| | GN2 bleed button (red) - press for 10 sec | | GN2 bleed button (red), located under pyro components cover, depressurizes probe retract system when depressed. |
| 4 | Disconnect & stow probe umbs | | |
| | Pull conn shell (yellow) & rot CCW to unlock | | |
| | Pull conn to remove, align yellow mark with stowage conn (yellow) & push to engage | | Stowage connector located on aft side of support beams. |
| | Rot conn shell CW to lock | | |
| | Repeat for sec prob umb (yellow) | | |
| | Close probe umb conn covers (2) (yellow) | | |
| | Position preload handle against stowed probe umb | | |
| | Preload sel lever - mid-position | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 5 | Fold probe | | |
| | Pull installation strut from clip on support beam, rot foot 180° & position against tunl wall between yellow marks | tunl | |
| | Rot capture latch rel handle lock CCW to unlock (orange stripe visible) | | |
| | Depress ratchet handle rel button (gray) & pull ratchet handle aft to full extension | | Ratchet handle release button (gray) is on aft end of ratchet handle. |
| | Depress ratchet handle rel button (gray) & push ratchet handle to first detent (red band only visible) | | |
| | Push ratchet handle outbd 30° & hold allowing probe to fold | | Probe fully folded when Teflon block on Z-support beam within 1/4 inch of ratchet housing. |
| | Probe will not fold | | |
| | Using tool F, rot jam nut & hex bolt (ratchet handle stop) CCW to remove bolt | | |
| | Push ratchet handle outd until probe releases & hold until probe folds | | |
| | (Subsequent installations of probe must be done very carefully to avoid releasing ratchet & folding probe while attempting to install it) | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | Depress ratchet handle rel button (gray) & pull ratchet handle aft to full extension | tunl | |
| | Push ratchet handle outbd 25° for one stroke only | | |
| | Depress ratchet handle rel button (gray) & with ratchet handle held inbd, push fully fwd to stow position | | |
| | Rot installation strut foot 180° to stow position & restow installation strut in clip on support beam | | |
| 6 | Rel probe from drogue | | |
| | Pull capture latch rel handle from recess, rot 180° CW & push fwd into recess | | |
| | Grasp probe support handle & pull aft to rel probe from drogue | | ≈25 pounds pull required to release probe. |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>x x | | |
| | If probe will not rel from drogue | | |
| | Pull installation strut from clip on support beam, rot foot 180° & position against tunl wall between yellow marks | | |
| | Depress ratchet handle rel button (gray) & pull ratchet handle aft to full extension | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | | Push ratchet handle outbd 25° to stop & repeat until support beams engage docking ring sockets | tunl | |
| | | Rot preload sel lever CCW (parallel to orange stripe) | | |
| | | Rot capture latch rel handle 180° CW & hold | | |
| | | Torque preload handle CW until capture latches rel from drogue | | |
| | | Fold probe, step 5 | | |
| | | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | | Remove probe from tunl & stow as req | | Temporary stowage provided on left-hand couch. |
| | 4.10.4.2 | Docking Probe Removal (LM side) | | Steps 1 and 3 only are required if probe previously installed for stowage. |
| | 1 | Pnl & tunl configuration | | |
| CMP | | PROBE (3) - OFF | 2 | PROBE EXTD/REL switch guarded. |
| | | cb DOCK PROBE (2) - open | 8 | |
| | | Drogue removed, 4.10.4.5 | tunl | |
| | 2 | Disconnect probe umbs (2) | | |
| | | Pull conn shell (yellow) inbd & rot CCW to unlock | | |
| | | Pull conn inbd to remove | | |
| | | Repeat for sec probe umb (yellow) | | |
| | | Close probe umb conn covers (2) (yellow) | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| | 3 | Fold probe | | |
| CMP | | Depress ratchet handle rel button (gray) & push ratchet handle toward CM, 1 inch to first detent | tunl | Ratchet handle release button (gray) on CM end of ratchet handle. An alternate method to release ratchet shaft is to pull release trigger (blue) on LM end of shaft. |
| LM side | | Unstow LM side rel handle (blue) by sliding handle toward LM to clear locking tang & rot toward LM to stop | | |
| | | CAUTION<br>Probe will move toward LM when released so precaution must be taken to prevent injury. | | |
| | | Push LM side rel handle outbd 30° & hold, allowing probe to fold | | This action could take up to 70 pounds of handle force. |
| | | Remove probe from tunl & stow as req | | Stowage for LM jettison provided in LM. |
| | 4.10.4.3 | Docking Probe Installation (CM side) | | Steps 1 through 6 required to install probe for stowage. Step 5 required only for probe stowage. |
| | 1 | Pnl & tunl configuration | | |
| CMP | | PROBE (3) - OFF (verify) | 2 | PROBE EXTD/REL switch guarded. |
| | | cb DOCK PROBE (2) - open | 8 | |
| | | Fwd hatch removed, 4.5.7.4 | tunl | |
| | | Drogue installed, 4.10.4.6 | | |
| | 2 | Remove probe from stowage | | Temporary stowage provided on left-hand couch. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | Pull capture latch rel handle from recess & rot 150° CCW to cock capture latches | tunl | Orange arrow on pyro cover should align with orange end at capture latch release handle. Do not force handle. |
| | | Move probe into tunl | | |
| | 3 | Engage capture latches | | |
| | | Push probe head into drogue until capture latches engage & lock | | A slight pull in aft direction will disengage capture latches if not fully engaged. |
| | | Rot capture latch rel handle CCW 30° to lock capture latches & push fwd into recess | | Colored ends of capture latch release handle should match colors on probe collar. Do not force handle. |
| | | Verify probe capture latch rel (LM side) button protrudes above probe head | | LM crewman must make this verification. Probe capture latch release button on LM side of drogue when capture latches engaged. |
| | 4 | Engage probe in docking ring | | |
| | | Pull installation strut from clip on support beam, rot foot 180° & position against tunl wall between yellow marks | | Yellow marks located on -Z axis. Probe support beam and corresponding docking ring socket color-coded yellow. |
| | | Depress ratchet handle rel button (gray) & pull ratchet handle aft to full extension (green & red bands visible) | | Ratchet handle release button (gray) on aft end of ratchet handle. |
| | | Push ratchet handle outboard 25° to stop & repeat until probe support beams (3) engage in docking ring sockets | | From this point ≈19 strokes required to install probe. An orange hash mark on collar conduit becomes visible when fully installed. Care should be exercised to ensure probe support beams (3) align with docking ring sockets and end of pitch arms do not interfere with docking latch fairings. |

TUNNEL MECHANICAL SYSTEMS

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| CMP | If pushing ratchet handle outbd does not advance support beams to engage docking ring sockets | | |
| | Depress ratchet handle rel button (gray) & push ratchet handle fwd to first detent (red band only visible) | tunl | |
| | Slowly push ratchet handle outbd ≈25° until ratchet pawl engages (audible click) & repeat until 3 probe support beams engage in docking ring sockets | | If ratchet pawl not audible, watch action of ratchet pawl indicator (red). |
| | (If ratchet handle is pushed outbd past point of pawl engagement, probe will rel) | | |
| | Verify ratchet pawl ind (red) is flush with ratchet housing | | |
| | If ratchet pawl ind is protruding above ratchet housing | | |
| | Push ratchet handle outbd 25° to stop & hold | | |
| | Press ratchet pawl ind (red) to seat pawl (ind flush) | | |
| | Return ratchet handle to full inbd position | | |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | Depress ratchet handle rel button (gray) & with ratchet handle held inbd, push fully fwd to stow position<br>Rot installation strut foot 180° to stow position & restow installation strut in clip on support beam | tunl | |
| | 5 | Adj preload handle in direction req to maintain support beams in an unloaded condition | | This step required only if probe installed in tunnel for stowage. Support beams may become loose in docking ring sockets. Rotate preload select lever CCW (parallel to orange stripe) to move extend latch aft (compress probe) and CW (away from orange stripe) to move extend latch forward (expand probe). |
| | | Position preload handle at a 45° angle to support beam (either side) | | Position provides clearance with forward hatch actuator handle. |
| | 6 | Push preload shaft fwd into detent<br>Push capture latch rel handle fwd into detent<br>Rot capture latch rel handle lock CW to lock (orange stripe not visible) | | |
| | 7 | Connect probe umbs | | This step not required when installing probe for stowage. |
| | | Pull probe umbs covers (2) (yellow) inbd & rot fwd to open | | Probe umbilical covers located in docking ring. |

| STA/T | STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|---|
| CMP | | Pull conn shell (yellow) aft & rot CCW to unlock<br>Pull conn to remove, align with docking ring conn (yellow) & push to engage<br>Rot conn shell CW to lock<br>Repeat for sec probe umb (yellow) | tunl | Probe umbilical connectors stowed on probe support beams. |
| | 4.10.4.4 | Docking Drogue Removal (CM side) | | Normally accomplished when all three crewmen are in CM prior to an IVT to LM and normally follows probe removal. |
| | | Docking probe removal, 4.10.4.1<br>Pull & rot (CCW) drogue lock lever until flush against tunl wall<br>Remove drogue | | Drogue outer ring should be grasped with both hands at opposite sides. Drogue lugs must move to left end of support fitting before drogue can be pushed free. Care must be taken not to strike LM hatch. |
| | | Rot (CW) & push until 3 drogue lugs clear support fittings<br>Rot toward CM & grasp any 2 handles<br>Mnvr drogue past support fittings & stow in CM | | Drogue must be canted and rotated to clear tunnel.<br>Drogue stowed under LMP couch. |
| | 4.10.4.5 | Docking Drogue Removal (LM side) | | |
| | 1 | Verify auto docking latches engaged (at least 3 engaged latches ≈120° apart) | tunl | Step 1 should be performed only after LOD. This could be visual verification or tactile verification using tool B if required. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | Push probe capture latch rel button tool B | tunl | Releases three probe capture latches and extend latch will engage automatically to prevent probe from re-extending. |
| | Probe head retracts from drogue (verify) | | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>If probe head does not retract from drogue<br>Remove probe from CM side, 4.10.4.1<br>Remove drogue, steps 2 & 4 or 4.10.4.4<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>If capture latches will not rel<br>Rel probe, 4.10.4.1, steps 1, 3, 2, 4, & 5<br>Rel drogue, step 2<br>Remove probe & drogue connected, & stow in LM<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | This procedure requires a crewman in both LM and CM. |
| 2 | Remove drogue<br>Rot drogue lock lever inbd 90°<br>Push drogue lock lever & rot 90° CW to unlock drogue<br>Rot drogue CCW until drogue lugs (3) clear tunl drogue supports (3) | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| 3 | Depress capture latch rel button with tool B & hold<br>Pull on drogue handle to rel capture latches | tunl | Step 3 should be performed only when probe and drogue were previously installed for stowage. |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>If capture latches will not rel<br>Rel probe, 4.10.4.1, steps 1, 3, 2, 4, & 5<br>Rel drogue, step 2<br>Remove probe & drogue connected, & stow in LM<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | This procedure requires a crewman in both LM and CM. |
| 4 | Remove drogue from tunl & stow in LM as req | | Stowage for LM jettison provided in LM. |
| 4.10.4.6 | Docking Drogue Installation (CM side) | | |
| | Procure drogue from stowage | | Drogue stowed under LMP couch. |
| | Install drogue<br>Mnvr past support fitting in LM tunl | | Drogue must be canted and rotated to clear support fittings in tunnel. Limited clearance between LM hatch and support fittings requires care in maneuvering drogue if closed. Handles should be used for support. |
| | Align drogue lugs (3) with support fittings in LM tunl | | Drogue must be held along outer diameter at opposite sides adjacent to drogue lugs. At this point drogue handles are facing LM hatch. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | Pull drogue lugs into support fittings & rot (CCW) until lugs hit stops in support fittings | tunl | Ramps on support fittings will guide drogue lugs into support fitting recesses. |
| | Push & rot drogue latch lever 90° (CW) | | This locks drogue latch mechanism. |
| 4.10.4.7 | Probe Preload Operation | | |
| | Rot preload sel lever CCW (parallel to orange stripe) | | |
| | Torque preload handle CW until load limiter releases | | Preload handle extension may be telescoped outboard to provide additional leverage if required. |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>If preload handle will not drive<br>Use tool F to drive hex fitting on aft end preload shaft in CW direction. Apply an estimated 30 to 40 lb on tool F handle<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | |
| | Verify capture latch rel button protudes above probe head | | LM crewman must make this verification. Capture latch release button on LM side of drogue when capture latches are engaged. |
| | Push preload handle inbd to detent & position at 45° angle to support beam (either side) | | Position provides clearance with forward hatch handle. |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | Preload sel lever - Rot to mid-position | tunl | |
| | Capture latch rel handle lock - locked position (orange stripe not visible) (verify) | | |
| 4.10.4.8 | Tunnel Latch Operations | | |
| 1 | Verify probe is preloaded, 4.10.4.7 | | |
| 2 | Cocking of latches | | Any suitable tool may be used to trigger release lever if desired. |
| | WARNING<br>To avoid possible injury to fingers or damage to the PGA, care must be taken not to place fingers under or near a latch while cocking, nor under or near the latch hook of a cocked latch. | | |
| | Depress rel button behind handle latch grip & pull latch handle down two complete strokes | | This procedure disengages and cocks latch. It may take only one complete stroke to cock each latch. |
| | If latch handle cannot be pulled<br>While pulling handle, depress rh no-back pawl on bottom until it disengages from ratchet tooth | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | If latch handle pulls free, remove press from rh no-back pawl & complete cocking procedures | tunl | |
| | If latch handle still cannot be pulled | | |
| | While pulling handle, depress lh no-back pawl through fairing covering hole with tools E and R until ratchet tooth disengages & latch handle pulls free | | |
| | Remove press from lh no-back pawl & complete cocking procedure | | |
| | If latch handle still cannot be pulled | | |
| | Remove fairing covering lh no-back pawl (using tools E and R) | | |
| | While pulling handle, depress both no-back pawls on the bottom until ratchet teeth are disengaged & latch handle pulls free | | |
| | Remove press from both no-back pawls & complete cocking procedure | | |
| | x<br>xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<br>x | | |
| | Verify hook rotates inbd to clear LM ring | | |

| STA/T STEP | PROCEDURE | PANEL | REMARKS |
|---|---|---|---|
| | If latch hook does not rel from LM ring on first stroke<br>Push top of AUX REL (yellow) button & proceed with sec stroke | tunl | |
| | Verify/push latch handle outbd against latch hook | | Prevents latch handle sticking inboard which could prevent the latch primary trigger from resetting after undocking. |
| 3 | Repeat step 2 until all 12 latches are disengaged & cocked | | Latches reset for subsequent docking operations. |
| 4 | Man triggering of latches<br>Push man rel lever at side of latches located | | This procedure engages latch. Manual release lever located at lower right side of latch handle. Use tool L to push manual release lever. |